A Discourse History of Technology Enhanced Learning Research (1945-2012)

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CERTIFICATE OF ORIGINAL AUTHORSHIP

I certify that the work in this thesis has not previously been submitted for a degree nor has it been submitted as part of requirements for a degree except as fully acknowledged within the text.

I also certify that the thesis has been written by me. Any help that I have received in my research work and the preparation of the thesis itself has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

Signature of Student:

Date: 14th December 2015

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Abstract

This thesis is an archival study which documents the discourse history of research that combines 'technology', 'learning' and the idea of 'enhancement'. Over the years this area of research has been known by many names, including 'Learning Technologies', 'e-learning' and most recently 'Technology Enhanced Learning' (TEL). In the space of 70 years (from 1945 to 2015), digital technologies has shifted from the stuff of science fiction, to being woven into the very fabric of how we experience learning, work and everyday life. These significant developments raise two questions *What is Technology Enhanced Learning (TEL) Research?* and *Where does it come from?* These questions frame the study.

While there has been some analysis of these questions in the TEL literature, certain approaches to knowledge production have dominated these, resulting in constraints on what is possible to imagine as TEL research. This thesis offers an alternative analysis by drawing on the tools and concepts of non-deterministic inquiry from original text by Michel Foucault, and actor network theorists Bruno Latour and John Law. A common thread in this lineage is the mobilisation of conceptual resources to stage empirical accounts in which theory and analysis are inseparable. Building on these influences this thesis is shaped by conceptual resources for exploring how discourse and relational socio-material constructions, make 'realities'.

This thesis makes a contribution to staging new ways of understanding *what TEL research is*, and *where it comes from*. It has contributed to new knowledge in four ways. First, by describing the discourse from engineering and how this is translated into *discourse materialised* in digital technology and learning design. Second, in accounts of *translation effects* where networks beyond the academy awakened to vested interests in funded research and what counts as 'learning'. Third in describing multiple active discourses around 'enhancement' and illustrating how these are regulated by *forms of ordering*. Finally, by speculating on spaces that have been opened up for imagining new 'realties' the work in this thesis is positioned as an alternative enactment that interferes with the self-evident.

Acronyms and abbreviations

AECT   Association of Educational Communication and Technology

AI   Artificial Intelligence

ALT   Association for Learning Technology

ANT   Actor-network theory

BBC   British Broadcasting Corporation

BCS   Computer Society

Becta   British Educational Communications and Technology Agency

CBT   Computer Based Learning

CORDIS   Community Research and Development Information Service

CSCL   Computer Supported Collaborative Learning

CSCW   Computer Supported Collaborative Learning

DCSF   Department for Children, Schools and Families (Britain) 2007-2010

DfE   Department for Education (Britain) 1992-1995, 2010

DfEE   Department for Education and Employment (Britain) 1995 -2001

DfES   UK Department for Education and Skills

DfES   Department for Education and Skills (Britain) 2001-2007

EPSRC   Engineering and Physical Science Research Council (UK)

ESDS   Economic and Social Data Service *UK)

ESRC   Economic and Science Research Council (UK)

EU   European Union

HCI   Human Computer Interaction

HCID   Human Computer Interaction Design

HE   Academy Higher Education Academy (UK)

ICT   Information and Communication Technology

ID   Instructional Design

IDS   Instructional Systems Design

IEEE   Institute of Electrical and Electronics Engineers

JISC   Joint Information Systems Committee

LLL   Lifelong Learning

NIACE   National Institute of Adult Continuing Education (UK)

OECD   Organisation for Economic Co-operation and Development

Ofsted   Office for Standards in Education

PC   Personal Computer

R&D   Research and Development

SSK   Sociology of Science Knowledge

STS   Science and Technology Studies

TED   archives Not for profit Technology, Entertainment and Design

TEL   Technology Enhanced Learning

TLRP   Teaching and Learning Research Programme UK

UNESCO United Nations Educational, Scientific and Cultural Organisation

www   World Wide Web

(Selwyn 2008, front cover)

(Leonard et al. 2007, fig.1)

(Underwood & Luckin 2011, fig. 1)

(Hawksey, 2012, posted JISC CETIS)

(Higgins et al. 2012, front cover)

Graphical depiction of TEL in 'wordle' cloud that gives prominence to words that appear most frequently in the source text.
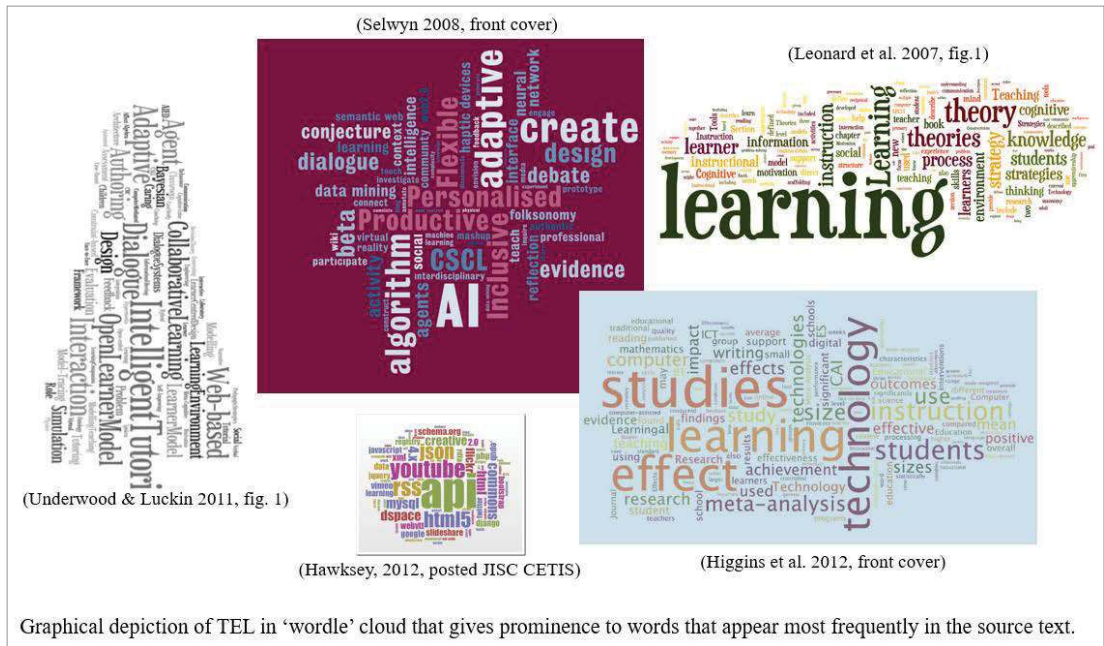
Chapter One: Starting with uncertain beginnings

> *Entities achieve their form as a consequence of the relations in which they are located. But this means that it also tells us that they are performed in, by, and through those relations. A consequence is that everything is uncertain and reversible, at least in principle. It is never given in the order of things. (Law 1999, p. 4)*

Introduction

This thesis describes a field of research that combines 'technology', 'learning' and the idea of 'enhancement', where 'technology' refers to computers, digital artefacts, and digital information and communication services. Over the years this field has been known by many names, such as: 'Computers in Education', 'Educational Technology', 'Learning Technologies', 'e-learning', 'Network Learning' and most recently, in Europe and the UK 'Technology Enhanced Learning' (TEL) (Bayne 2015). In spite of its many names, past and present, what is clear is that the field has shifted from relative obscurity to one that has international presence today (Squires et al. 2000; Dyke et al. 2007; Dueber 2004;

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Jones et al., 2010; Jones & Czerniewicz 2011). This significant shift from niche research to pervasive presence raises some simple questions:

- What is Technology Enhanced Learning (TEL) Research?
- Where has it come from?

Some would say that these questions have already been answered. TEL is an established research field with a strong agenda and a clear lineage (Reigeluth & Carr-Chellman 2009). It is true that what should, and should not be, part of TEL research has received much attention in various reviews (Abrami et al. 2006; Beetham 2005; Pollard & Pollard 2005; Taylor et al. 2004). Moreover, many fields of inquiry are polemical and TEL research is no exception. Buckingham (2007) and Orlando (2014), for example, report that there is evidence that computers and the internet have caused wide-ranging changes in teaching and learning practices, while others (e.g. Chirgwin 2013; Wong 2007) suggest they have been of limited effective use. There are extensive, research-based publications on how technology can be designed and deployed to enhance learning (Mayes & Freitas 2005; Laurillard 2002, 2012; Salmon 2013); alongside, critical international government reports on lack of "sustainable innovations" into how e-learning can make a difference to learning outcomes (HECTIC 2002, p. 5). In the UK, policy makers (Blunkett 2000) and education leaders (Whitty 2006) criticised education researchers for the quality and relevance of their research; and TEL researchers for lack of collaboration between computer scientists, cognitive scientists and educationalist (TEL call for funding documents1 2006, 2007).

The Wordle image that introduce this chapter capture something of the representations of TEL pedagogy and TEL research. 'Learning' is there and so is 'technology'; 'enhancement' is implied, but then other words crowd in: outcomes, instruction, theory, design meta-analysis, personalisation, algorithm, evidence, community, cognitive, motivation, information, inclusion, flexibility. The list is

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[1] These documents are also known by the shorter version of the title: TEL call documents (2006, 2007)

potentially sprawling and endless. Yet in many depictions of TEL, like the images at the beginning of the chapter, there is an assumed *certainty* that each entity is separate and knowable, that the 'technologies' are separate from 'learning', and that the relations between things are unambiguous and suspended in time. TEL researchers (including myself) don't usually question the confident meta-narratives that make these images recognisable and acceptable as truths. This phenomenon is an example of modernity that is founded on a strong faith in rationality, rational science and the certainty of progress (Nicoll 2006; Lyotard 1984).

To me this certainty seems fragile in the face of contingencies involved in doing TEL research and becoming a TEL researcher. My relationship with TEL research is littered with opportunistic contingencies. In the 1970s I was a social science undergraduate in the UK following the work of Latour and Woolgar (1979) in Laboratory Life, along with television documentaries[2] that were being broadcast at the time about new technologies (Evans 1979). In the 1980s I was a History teacher in a school where I ran the computer club and experimented with programming the BBC micro for teaching literacy (Allen & Albury 1980). In the 1990s I was a Human Computer Interaction Design Researcher working on knowledge-based systems (Patel & Sutcliffe 1993; Sutcliffe & Patel 1996). Since 1997, I have worked on funded research projects that are about 'technology' and 'learning' and this makes me a TEL researcher (Patel et al. 2007)

One funded project on which I was employed as a TEL researcher was about semantic technologies and learning. It was called *Ensemble* (Carmichael & Patel 2007). This was one of the eight projects and seven pilot projects funded by the UK Technology Enhanced Learning (TEL) Programme (2007–2012); and the fifth phase of the UK Teaching and Learning Research Programme (TLRP), which began in 2000. Bidding for funding for the *Ensemble* project involved close

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[2] *Now the Chips are Down, Horizon,* BBC, tx. 31 March 1978; *The Mighty Mico,* ITV, 1979. Six part series, tx. Monday 29 October 1979

analysis of the TEL call for funding documents (2006, 2007). This is relevant for two reasons.

First, it was personally a formative experience. I began to understand bid writing as discursive work which constructed the *Ensemble* project by assembling all manner of heterogeneous things, including: ideas, technologies, academic track records, demonstrations, theories of learning, design rubric, stakeholders, events, promises, methods, forms, finances, policy evidence, and references to past research. What followed from this is the question: If bid writing is discursive, then in what ways are other TEL entities also discursively constructed? In other words: What discursive work is involved in constructions of TEL technology, documents, images and other materials?

Second, these TEL call for funding documents (2006, 2007) can also be seen as marking an important juncture in the history of TEL. The TEL Programme investment of £12m was unprecedented funding for research into 'learning and technology', but this came with accountabilities that controlled what was possible to investigate. Funding for the TEL programme was part of a perceived crisis in the utility of funded research for policy goals (Blunkett, 2000). This means that the history of TEL research is part of the complex relationship between research, policy and practice. Strathern (2004) in her book entitled *Commons and Borderlands* explores the relationships around discipline, accountabilities and flow of knowledge. It was in these encounters with the TEL call for funding documents that I began to wonder about the flows of knowledge across boundaries and over time, and the discourse history of TEL research.

These days TEL researchers draw on theories of learning from Cognitive Science, Education Studies, and broadly the Social Sciences. TEL researchers are computer scientists and programmers, software engineers and analysts, information scientists and educationalists, psychologists and sociologists, linguists, designers, and learning technologists. Some TEL research is associated with Human Computer Interaction Design (HCID), and Computer Supported Collaborative

Learning (CSCL). Many TEL researchers (including myself) are captivated by imagined futures envisioned in TEL research. Some of us find interaction with digital artefacts immensely enjoyable, and programming and solving design problems deeply satisfying. Many TEL researchers, including myself, have had the experience of making a better life through education and believe in the transformative power of learning. But then again what makes this turn into evangelical zeal, and where does personal and collective success and failure, triumph and disappointment fit in?

As a TEL researcher I began to understand the TEL call for funding documents (2006, 2007) as gatherings of things: passions, pasts, hopes, experiences, differences, subjectivities, technologies, policies, and theories of learning, forms of measuring and more. In this space of possibilities, the intuition of *uncertainty* can be understood as the proverbial elephant in the room.

Starting with uncertain beginnings changes possible responses to the questions: *What is TEL research?* and *Where does TEL research come from?* It implies a non-deterministic ontology where research is about how things come to be as they are, and how they are constructed. To say that TEL research is constructed is to say that it has come from somewhere, that it has a history, and so research into finding this history will involve empirically tracing the process by which it has come to be what it is. One important writer who is known for his critiques of deterministic inquiry and modernist rationality is Michel Foucault (1995, 2001a, 2001b, 2003). He conceptualises discourse as the combined effects of language and action, subjectivities and organisations, legitimacy and authority (1991, 2002). Foucauldian discourse is ways of thinking and possibilities for action that involve construction and maintenance work (2002). TEL research, as a recognisable field of inquiry, has what Foucault might call the "history of the present" (Rabinow & Rose 2003, p19). As a shorthand, I use the phrase 'the discourse history of TEL research', and that is what this thesis is about.

Framing a research problematic as a discourse history has been done many times in the works of philosophers like Foucault (2001a, 2001b, 2002, 2003), and actor-network theory scholars from Science and Technology Studies (STS) (cf. Kendall & Wickham 1999; Sismondo 2009). In the work of these scholars the problematic is the noun version of the verb to problematise. To problematise is different from problem-solving research which takes for granted the existence of received narratives about social structures, theories of reality and research methods and operates within them (Popper 2002). This means that while problem-solving research is a dominant paradigm in TEL research (cf. Conole & Oliver 2007; Laurillard 2012), the idea of non-deterministic inquiry as a research problematic is new in the world of TEL research. The opening quote to this chapter comes from John Law, who is one of the founders of actor-network theory. He is saying that entities don't have any inherent essence but become what they are as a result of relations with other things. In this ontology, the field of TEL research emerges from relations between things that include 'technology', 'learning' and 'enhancement'. Law is saying that before entities are established as truths, what they are and what they will become, is uncertain. In a non-deterministic framing of TEL research, it is not possible to know, before it happens, what entities will be successfully enrolled or how relations might translate these entities. One of the recurring arguments in this thesis, is that this non-deterministic, relational conceptualisation of inquiry opens up new ways of understanding *what TEL research is,* and *where it comes from*.

I started by saying that TEL research has been known by many names. This focus on 'names' and 'naming' suggests that it is not self-evident *what TEL research is* or *where it comes form*. In response I am advocating using conceptual resources from Foucault (1991, 2002), and actor-network theorist Law (2004, 2009) and Latour (2005, 2014) to study the discourse history of TEL research. Their works characterise non-deterministic inquiry, and forms of discursive writing in which theory, descriptions and analysis are intertwined. I propose to adopt this to frame the inquiry in this thesis.

The four remaining sections in this chapter are organised to introduce the work in this thesis. They are:

- *TEL(ing) history.* This first section draws on Foucault's (2002) explanation of historical interruptions, to describes six historical shifts in the way TEL research has been practised and understood. This introduces a wide ranging history of where TEL research comes from.

- *The problematic.* This short section, explains why this history is a beginning and not the end, and in doing so opens up the research questions as a problematic of non-deterministic inquiry.

- *Conceptual resources.* This section introduces Foucauldian discourse, and the idea of relational socio-material constructions from actor-network theory. I explain how these two influences on my study are related and different, yet relevant to exploring the discourse history of TEL research. The discussion introduces a vocabulary that is used extensively throughout the inquiry process.

- *Configuring the inquiry.* This section describes how the conceptual resources are mobilised for data gathering, analysis, structuring and writing the thesis.

The chapter ends with a summary of how the thesis is organised.

TEL(ing) history

In many textbooks on TEL research, history is presented as 'context' and is offered to 'orientate' the reader (cf. Bates 2005; Conole & Oliver 2007; Januszewski 2001; A Roadmap of Educational Technology 2010). This means that accounts of where TEL research comes from are relegated to the background and separated from its 'present'. In Foucault's writings (e.g. Foucault 2002), research that works with historical data is most productive when detecting discursive shifts in the ways knowledge is understood and acted on. These shifts

are differences between what went 'before' in relation to the 'next' and the 'present'.

To study differences, Foucault draws attention to the phenomena of rupture, or discontinuity. He explains it like this:

> "beneath the persistence of a particular genre, form, discipline, or theoretical activity, one is now trying to detect the incidence of interruptions. Interruptions whose status and nature vary considerably…..suspend the continuous accumulation of knowledge, interrupt its slow development, and force it to enter a new time, cut it off from its empirical origins and its original motivations, cleanse it of its imaginary complicities; they direct historical analysis away from the search for silent beginnings, and the never-ending tracing-back to original precursors, towards the search for a new type of rationality and its various effects" (Foucault 2002, pp. 4-5).

An interruption in these terms is a shift in the prevailing ways of thinking, acting, and legitimising. Interruptions are neither entirely chronological nor independent of time; they are not causes but they do have effects. This makes *interruptions* a useful frame for organising an introductory history of TEL research, because it interprets relevance broadly and so can reference a wide range of materials. It also describes change without suggesting completion at the outset, and does not deny the provisional status of writing a history to 'orientate' the reader. Six interruptions will now be described to introduce the field of TEL research.

The first interruption, broadly conceived, was the shift *from* imaginary ideas that are represented in words and symbols *to* physical artefacts that can be demonstrated.

There was a time when imagined possibilities for processing machines were conceived in theory and illustrated in art installations (Haque 2007) and science fiction (cf. Bush 1945); and this was celebrated as new knowledge. Boden (2006)

describes imagined possibilities as harbingers that make the unthinkable imaginable. These are not usually included in any history of TEL, but feature extensively in the history of cognitive science, computer science and the related field of artificial intelligence (Boden 2006). The early harbingers were conceptual programs that were demonstrated on paper. In this way, digital technology was symbolic and representational rather than physical (Turing 2004; McCarthy et al. 1955; Newell & Simon 1958).

The interruption was an effect of the gathering of forces. One example is the coming together of researchers interested in what it means to learn, and what technology could do for learning. Critically, there was no disciplinary division of labour so these early TEL researchers were engineers, psychologists, philosophers, computer scientists, educationalist and linguists who were located in industry, schools, community colleges, and higher education (McCarthy et al. 1955).

New publication practices and regular conferences were important milestones in connecting significant others interested in computers and learning and in the broader studies of 'mind and machine', and 'human machine intelligence' (Boden 2006). Early collaborations between computer scientists and cognitive scientists led to official bureaucratic recognition through the funding of experimental computer laboratories (McCorduck 1979; Fleck 1982). Early papers, the forerunners of TEL research, mixed different orders of knowledge by combining speculative descriptions with formal logic, and describing software designs which could not be wholly realised with the available technology.

An effect of these emerging connections was a shift in expectations around demonstrating the validity of research claims. More specifically for knowledge to be persuasive, software programs had to be shown to be physically executable on a machine. In 1945 'As We May Think' (Bush 1945) was published as a vision of the future, but by the 1960s 'Steps Towards Artificial Intelligence' (Minsky 1961) was published because it was accompanied by a concept demonstration. This was

an interruption in that paper proof was no longer enough; there was growing peer pressure to show working programs that demonstrated the possibility of what was being imagined (Boden 2006).

The second interruption was the shift *from* thinking about human-machine relations in terms of automata *to* imagining human-machine interactions that are more intimately co-dependent.

Automata are physical devices that act in ways usually associated with living animate beings. Suchman (2007) notes that in 14th Century Europe, 'learned men' were believed to perform with talking brass heads. Suchman notes particularly the influence of Julien de la Mettrie's (1994) book, *Man the Machine*[3]:

> He argued that the vitality characteristic of human being was the result of their physical structure rather than either something immanent in their material substance or some immaterial force, Cognitive scientists today maintain the [same] basic premise … with respect to mind, contending that mind is best viewed as neither substance nor insubstantial, but as abstractable structure implementable in any number of possible physical substrates. (Suchman 2007, pp. 35-36).

The influential new idea is that 'intelligence'; that is embodied in the brain, may be understood in the abstract and then embodied in other forms. In other words, cognition may be literally understood as information processing or computing. Such ideas open the possibility of thinking about humans and machines as equivalent in that both process information, albeit using different hardware. An emergent effect of this way of thinking has been the possibility of equivalence in human–machine relations.

Drawing on Turkle (1984), Suchman draws attention to the special challenges that computational artefacts pose to the long-standing distinction between the physical

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[3] First published in 1748

machines that are designed and used, and social beings capable of communications (Suchman 2007). This is a marked shift because previously constructs such as 'conversation', 'interaction', 'learning' and 'intelligence' were once reserved for uniquely human activity, and signified humanity; the same terms are now routinely used to describe human-machine relations. An example is how 'interaction', in the sense of mutual intelligibility between human and machine, has been adopted widely to describe exchanges between people and digital artefacts. Another example is that some TEL researchers from Cognitive Science and Artificial Intelligence communities conceptualise machine and human 'learning' and 'intelligence' in equivalent terms (Boden 2006; Luckin & Underwood 2011). Yet another example is evident in early accounts of design research where knowledge is structured to enable dialogue between the machine as tutor and the human learner[4] (Englebart 1962). However this was not "practical in the research-lab sense until the 1960s, nor in the commercial sense until the 1980s [and many of the technologies] were born/reborn several times within a half-century" (Boden 2006, p. 726).

The third interruption runs in parallel with the previous shift. It was the change *from* thinking about human-machine relations and interactions *to* the materialization of physical designs of digital technology and representations of 'learning'.

The need to make digital computers usable by more people moved higher in the research agenda as the processing power of research systems grew inexorably. In 1959 Engelbart's group at the Stanford Research Institute began working on a system that would come to be called NLS, or oNLine Systems (Nyce & Kahn 1991). The NLS was eventually demonstrated at the 1968 computer Conference in San Francisco to an audience of 3,000 computer scientists who attended a two-hour demonstration that ended with a standing ovation. This is interesting because in retrospect this work has legendary status, but it took 10 years to turn some of the science fiction ideas into a reliably functioning system that could be

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[4] For an extended example from Englebart 1962 see Appendix A: End Note 1

demonstrated. While this work was in progress there were no certainties that the different parts of the system would work. Indeed at the time Englebart's group were regarded as outdated engineers by some computer scientists (cf. Rheingold 1985).

Englebart (1962) and his group worked on demonstrating human-computer 'synergy' or symbiosis in which the machine was experienced as a linguist (it seemed to understand a subset of language) that was interactive (using human conversation). The list of the features demonstrated in the NLS system included, for example: word processing, keyword search, message passing (i.e. email), multiple overlapping windows, and the screen cursor. Engelbart (1962), writing about the complex information processing said: "In a very real sense, as represented by the steady evolution of our augmentation means [writings, printing, libraries …], the development of 'artificial intelligence' has been going on for centuries" (p. 79). Moreover he argued that the process of human-computer communications augmented human capabilities so that people from all professions could solve the problems that, before computers, were regarded as unsolvable. In research that combined this way of thinking about human-machine relations with demonstration, a physical reality was being materialised. This means that engineering, computer science and cognitive science share a history that is also part of the history of TEL research.

The effects of these alliances was to enrol philosophical concepts like motivation, learning, and memory into what Suchman (2007) calls commitments to scientism. She writes:

> The cognitivist strategy is to interject a mental operation, between environmental stimulus and behavioral response: in essence, to relocate the causes of action from the environment that impinges on the actor to processes, abstractable as computation, in the actor's head. The first premise of cognitive science, therefore, is that people (or "cognizers" of any sort) act on the basis of symbolic representations: a kind of cognitive code,

instantiated in the brain, on which operations are performed to produce mental states. (p. 37)

A new edifice of technical constructs signified this ontological shift. Terms like 'planning', 'representation', 'problem solving', 'cache memory', 'error', and 'knowledge structure' characterised this historical interruption in the work of many prominent researchers[5] including Bruner and Miller (Hergenhahn 2008), Minsky (1961) and Seymour Papert (1980/1993).

The fourth interruption was a change in what was counted as TEL research when an expanding universe of users and researchers had access to programmable computers.

Before this interruption computers were experimental demonstrations. Research and its presentation had only been possible within the specialised environment of research laboratories. Mainframe computers were used in government and corporate environment but it was entrepreneurship combined with scientific know-how that created the technology that became IBM and later the personal computer (PC) (Campbell-Kelly et. al. 2013; Tatnall 2010).

Initially this was not something that anybody could afford, though word was spreading about personal computing through Homebrew[6] computer clubs, and publications like the *Whole World Catalog*. Steve Jobs compared *The Whole Earth Catalog*, to the internet search engine *Google* in his June 2005 Stanford University commencement speech:

> When I was young, there was an amazing publication called *The Whole Earth Catalog*, which was one of the bibles of my generation … It was sort of like *Google* in paperback form, 35 years before *Google* came along. It

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[5] For more on the work of Bruner & Miller, Minsky and Papert see Appendix A: End Note 2
[6] Computer History Museum, Online Exhibition. Personal Computers /The Homebrew Computer Club. 1996-2015

was idealistic and overflowing with neat tools and great notions. (Jobs 2005; Isaacson 2011).

This is relevant because in the 1970s in the US, and in the 1980s in the UK, this network of counter-culture enthusiasts grew in tandem with the development of affordable PCs (Allen & Albury 1980; Isaacson 2011; Stross 1997). Access to PCs combined with networks of enthusiasts, lowered the threshold for usability of computers and made programming and application development easier to access and learn (Campbell-Kelly et. al. 2013; Wurster 2002).

Contrary to popular history of computing, this interruption was *not* caused by new inventions. A combination of known technologies, and easier and faster access, made it possible for enthusiasts, developers and researchers to make useful and rewarding software applications without a research degree in computer science (Arthur 2010). For example, the internet had been used for some time by the military and academia but the release of the mosaic web browser in 1994 made it possible to publish information on the internet and facilitate design interaction for a wider audience (Andreessen & Bina 1994; Berners-Lee 1996; Tatnall 2010). Users could use the 'view source' menu item to see the HTML coding, and the copy left trademark legitimated copying, adapting and reusing source code, albeit with attribution. (Raymond 2001).

What has access to programmable PCs to do with 'learning' and the history of TEL research? One response to this question is that without a general population having access to PCs, and networks that support learning for general users, programmers and researchers, there is no 'technology' in TEL. This then raises the question of what fuelled the early demand for computers as desirable objects, and the desire to learn with, about and through computers. Another response is that this history of programmable PCs is mostly undocumented in contemporary accounts of TEL research. It is invisible in effect. This is in itself an interesting phenomenon and a part of the discourse history of TEL that can be excavated to understand *what TEL is and where it comes from.*

The fifth interruption was the proliferation of TEL as an object of interest and concern for business, governmental organisations, and institutions of formal education. This was, in other words, a shift *from* TEL research as informal learning and niche research *to* TEL research as a mainstream and institutionalised activity.

The mainstreaming of TEL is marked by governments, education institutions and commercial organisations investing in technology for education and training purposes. Today most aspirational nations have a policy on TEL as well as professional and standards bodies. Examples are the *Towards a Unified e-Learning Strategy* in the UK (DfES UK 2003) and the widespread adoption of Learning Environments by Institutions of Higher Education, with policy on how this is used, monitored, managed and policed (Britain & Liber 2004; Dutton et al. 2004). The familiar term e-learning was coined to market technology-enhanced training in business (Cross 2004) and has subsequently been widely adopted in policy documents (HECTIC 2002), and by professional associations (e.g. the UK *Association of Learning Technolog*y). Several writers have argued that terms like e-learning are obsolete since all learning and pedagogy now deploys digital technology and is therefore blended in some way (cf. Driscoll 2002; Oliver & Trigwell 2005). In these arguments, TEL technologies are regarded in the same way as technologies for writing, printing and mass publication; all such technologies change what is taught, how learning takes place and who is entitled to education (Shaffer & Clinton 2006). Taken together these writers suggest that the presence of technology in places of learning is so familiar and commonplace that, like reading and writing, the problematic of what it is and what it does is becoming invisible in everyday teaching and learning and perhaps also in TEL research projects.

Taken at face value the history of TEL research is one of modernist progress and transformation (Effective Practice in the Digital Age 2010) that is primarily concerned with policy, management, and practice. This shift has prompted particular kinds of instrumental questions in the domain of TEL research,

examples being: "What learning platforms are used and how do they compare? [and] What functionality of different tools is being used by tutors and students and for what purposes?" (Conole & Oliver 2007, p. 18). In this shifting landscape of connected networks, one way into understanding *What is TEL research?* and *Where it comes from?*, – is to explore these discourses and where they come from.

The sixth interruption was the shift *from* a rich and contingent variety of networks associated with TEL research *to* regimes of funding research that are consciously geared towards policy goals and improving practice.

In the UK, the TEL Research Programme (2007–2012) was positioned as a follow up to the Teaching and Learning Research Programme, TLRP, (1999–2009). This was the UK's largest ever educational research programme, spanning 10 years and coordinating 7,000 researchers and more than 10 research projects. The association between TEL and TLRP Programmes drew TEL researchers into conflicts around the perceived failures of education research. The director of the TLRP Programme (Pollard 2002) called this a crisis of confidence, and core commitments of the TLRP Programme were extended to the TEL Programme. He wrote:

> Those working in the field have certainly been on the back foot … Without doubt, there is room for improvement in the rigor, accessibility and relevance of educational research … …Our mission is to conduct research to enhance a broad range of learning outcomes of relevance to individuals, educational institutions, workplaces and our society as a whole. Our work will contribute to individual opportunity, economic productivity and social cohesion, and to the new foundations of evidence-informed policy and practice in education. (p. 3)

In this framing, 'outcomes' and 'evidence' are positioned as indicators of progress and 'relevant' research. TEL research projects were expected to deliver

measurable outcomes and impact (James & Brown 2005). When the TEL call for funding documents was published in 2006 and 2007, it was not possible to be a nationally funded TEL researcher without articulating how the proposed research fitted in with education policy goals and would improve practice.

The TEL call for funding documents (2006, 2007) and the eight projects funded by the TEL programme mark an important gathering in the field of TEL research. The differences amongst TEL researchers in terms of disciplines, community loyalties, training, professional affiliations, knowledge and skills is evident in these projects. These researchers have come together to write successful bids and do TEL research. Later in this chapter (and throughout this thesis) I will return to this juncture as a vantage point from which to explore my research questions.

The problematic

The TEL history described in the previous section matters in that each interruption contains an account of what was for a time authorised and legitimate knowledge, *and* how this changed. There was a time when knowledge was embodied in mathematical and symbolic representations but this changed when the proof of concept required implementing ideas in a working demonstration. There was also a time before the design of human-machine interactions was changed to feel like a conversation and an intimate relationship; in the 1970s and 1980s, TEL research was taken up informally outside the academy but this changed with the advent of e-learning in the 1990s. In the UK the association between the TEL and the TLRP programmes changed research accountabilities and therefore the type of projects that were funded as legitimate TEL research.

In the early history of TEL research the relationships between 'learning' and 'technology' was recognised as a subject of research. However, today it is difficult to think about learning or knowledge without its relation to the internet and digital technologies. In recognising this significant shift it is clear that what is funded as TEL research has also changed over time. However the interruptions

described in the previous section are not definitive. Their history is set out to orientate the reader – it is not the end but the beginning. Foucauldian and actor-network analysis are non-deterministic in recognising that change can be messy and it can work in surprising ways (Nespor 2002).

Nespor (2012) makes three points about TEL history. First, the effect of an association between things might be immediate or delayed. Second, over time differences have implications for how boundaries are made, for example, between disciplines, and between research, policy and practice. Third, "the historical-geographic junctions at which events unfold are the key to their meaning and implications" (p. 19). The TEL Programme and the TEL call for funding documents are historically and geographically specific. These insights speak to my intuitions about uncertainty, and transform what appear to be simple questions – *What is TEL research?* and *Where does it come from?* – into a problematic of non-deterministic inquiry.

Non-deterministic inquiry matters because potentially it is a new way of understanding TEL research. In Law's (2013) words: "What is at stake at the end of the day is: How might practices that don't cohere fit together in good ways if consistency and coherence are less important than they were?" (p. 1). At the same time, and reassuringly, this form of inquiry has deep and rich roots in the field of Science and Technology Studies (STS), and in particular actor-network theory and Foucauldian Discourse analysis (discussed later in this chapter). STS has existed since the 1960s and there is a well-developed body of knowledge around studying the processes and effects of science and technology in many fields, including engineering, health care, farming, e-science, science policy, and genetics (Asdal et al. 2007; Law et al. 2013; Latour 1996, 2007; Sismondo, 2010).

My research questions, *What is TEL is research? and Where does it come from?* are a conceptual problematic. This conceptual problematic is tackled by writing a discourse history of TEL research that allows uncertainty *and* the emergence of things that are real in effect, for example, 'digital technologies', 'learning' and

'enhancement'. To do this I draw on the intellectual lineage of non-deterministic inquiry. The conceptual resources and vocabulary that are central to this kind of research are discussed next.

Conceptual resources

Recent accounts of TEL research that have been funded by governments and professional associations can be described as deterministic because they assign particular powers to technological interventions. They assume that digital technology is a ubiquitous and uniform presence (Squires et al. 2000; McAndrew et al. 2010; Noss et al. 2012), and that the 'technology' can be optimised, exploited, and deployed for teaching and learning (cf. Laurillard 2002, 2012; Noss et al 2013; Salmon 2013). In mainstream TEL research, researchers tend to claim truths about pedagogical interventions and technology design. For example, technologies are characterised as having affordances and these are analytically mapped to 'learning needs' or 'characterisations of what it takes to learn' (Beetham 2005; Laurillard 2002; Effective Practice in the Digital Age 2010). There are some exceptions, as has been seen in the more recent turn to materiality in education research (Fenwick and Edwards 2011, Sorensen, 2009), and Rimpiläinen's PhD (2012) on enactments of TEL research. However mainstream TEL research, based on particular epistemological and ontological assumptions, has come to be regarded as more or less common sense. Common sense is powerful in validating what it is possible to think and do in shaping the space of inquiry. This is not a criticism of this form of TEL research per se. It is the status of this common sense, and the search for essentialist and prescriptive truths that is addressed by the work in this thesis.

In mainstream TEL research, common sense that is taken for granted, relies on essentialism, Essentialism is the idea that everything including society, humans, material objects and natural entities has fixed essences that exhaust *what* a thing is (Toennesen 2005; Glyno et al. 2009; Latour 2014; Law 2009). Broadly the non-deterministic traditions that inform this thesis are responses to the problem of

essentialism. Arguing against essentialism, Foucault (2002), Law (2004) and Latour (2005) (as examples) stress irreduction. Foucault puts aside the category of essential meaning and instead sets out to scrutinise transformation to interrogate how it works, how it does what it does. More technically this is captured in what can be described as *Foucauldian discourse and discourse analysis* (Foucault 1991, 2001a, 2001b, 2002, 2003). Law and Latour advocate treating everything in the social, natural and designed world as a continuously generated network of relations or more technically, *relational effects* (Latour 1987, 1993, 1996, 2005; Law 2000, 2002, 2004, 2006). Such commitments question the possibility of 'absolute solutions' and 'essential truths'. But this in turn raises questions about the relevance and usefulness of an inquiry into TEL research. This section introduces the writers and conceptual resources that address these tensions and inform my investigation. This is organised as follows:

- *The orientation review.* I start with a review of key concepts and vocabularies from the work of Foucault and actor-network theorists Law and Latour. This review includes a critique of both, and comments on similarities and differences.

- *Gathering key constructs.* Here I describe how concepts from actor-network theory can extend Foucauldian conceptions of discourse and discourse analysis.

- *Matter of new knowledge.* This describes the relationship between non-deterministic and deterministic forms of research and what this means for new ways of understanding *What TEL research is* and *where it comes from.*

The orientation review. The orientation review begins with Michel Foucault (1926-1984) because the research in this thesis is framed as a non-deterministic inquiry and draws in various ways from his significant oeuvre (Kelly 2010). Foucault's work is immensely influential across a range of humanities and social sciences disciplines, and across newer fields such as science and technology

studies (STS), cultural studies, gender studies and postcolonial studies (Diaz-Bone et al. 2007). He has also been regarded with some hostility partly due to his methodological programme in which he refuses to "delve behind the surface appearance of things in order to discover their real meaning." (Rose 2007, p.144). Because of this it is difficult to begin with Foucault without some first explaining his legacy in relation to discourse analysis; and second describing the relationship between the genesis and dissemination of his primary texts.

Firstly, Foucault's legacy in relation to discourse analysis is complex. Some of this complexity lies in the widespread and multiple sets of definitions and uses of discourse analysis. There are, for example, forms of influential discourse analysis that are unrelated to Foucault (Fairclough 1995), and some of these include linguistic approaches that are concerned with the analysis of grammatical structure of narratives (Diaz-Bone et al. 2007). At the same time, Foucault has influenced some socio-linguistic and constructivist research such as discursive constructionism that is defined by text and talk which construct social practices through interaction (Potter & Hepburn 2008). Some studies that are described as content analysis and conversation analysis are concerned with systematic qualitative study of language and constructions as a means to 'discovering' intrinsic hidden meanings (Wooffitt 2005). Furthermore in political science analysis in particular Glynos et al (2009) in their review of variety of discourse analysis and methods write, "discourse has taken on a vast array of meanings over the last century or so, ranging from natural language, speech, and writing, to almost anything that acts as a carrier of signification, including social and political practices." (p.3). A pathway through this quagmire is to rely on Foucault's primary text on methodology including the *Archaeology of Knowledge* (2002) and the transcript of an interview with Foucault in 1981 on the *Question of Method* (1991).

Secondly relationship between the publications of Foucault's work in French and the later translations and reprints is complex. This is because the English translation of works by Foucault did not follow the order originally published in

French, and many of Foucault's shorter works that are translated into English are spread across many overlapping anthologies. Never-the-less the popularity of Foucault's writings and interviews means that many of his texts are being reprinted as first edition[7] classics. This is relevant because these commercial drivers, combined with the very material phenomenon of publishing and scholarship in the digital age (Peters & Roberts 2012), have given rise to disjuncture between the sequence of Foucault's intellectual lineage and the sequence of publications and reprints of Foucault's work. This is why, in the orientation review that follows, Foucault's primary texts seem to be recent publications, but the accompanying account will refer to different phases of Foucault's work. Moving forward from these explanations it is now possible to return to a review of Foucault's work and how this has been mobilised in this thesis.

Foucault's work can be characterised as historical research that examines the production of truths and realities. However this descriptor does not do justice to the range of empirical analysis that demonstrates his theoretical arguments, and this includes how he sets up the problematic[8]. For example The *History of Madness* describes two different systems of truths in relation to *what is madness*, and demonstrates that both are regarded as realties at different times in history. In *Discipline and Punish* the same transformation of realities is demonstrated in relation to *crime and punishment*. In both the problematic is set up as 'how did this change take place'. These are examples of Foucauldian empirical investigations into the construction of realities and emergent effects such as the pathology of 'unreason', and 'discipline' as a form of control. The studies are examples of inquiry that can be understood as discourse history. A discourse history of TEL research has been conceived in this way as a problematic of change.

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[7] *Archaeology of Knowledge* is an example of this. It was first published in French in 1969, then in English in 1972 by Tavistock Publications Limited. The Routledge edition came out in 1989 and was reprinted as a 1st edition Routledge Classic in 2002.

[8] See Appendix A: End Note 3, for more on how Foucault's sets up the problematic in the *History of Madness* (2001), and Discipline and Punishment subtitled The Birth of the Prison (1995)

The volume of Foucauldian scholarship combined with development in Foucault's ideas over a period of years means that his legacy is complex. Foucault wrote extensively about the archaeology of knowledge before announcing his genealogy project at the inaugural lecture at the Collège de France in 1970. As noted by Nicoll, "The former [archaeology] is more akin to literary criticism, whilst the latter [genealogy] locates textual practices and their criticism within a broader framework of the production of knowledge and the exercise of power." (2006, p.3). Genealogy extends archaeology by extending attention to what Foucault describes as the history of the present (ibid 1970). This extends the scope of what counts as discourse and is motivated by contemporary concerns about where current states of affairs come from. For example in *Discipline and Punishment* (1995) Foucault adopts an extended notion of discourse including institutional practices, document archives, rules of inclusion and exclusion, architecture, sentencing conventions, the science and criminology, and publications that are moralising and philanthropic.

Foucault has influenced the framing of the inquiry in this thesis in that the discourse history of TEL research is conceived as both a problem of change i.e. *Where does TEL research come from?* and as a problem of what it i.e. *What is TEL research.* However the relationship between Foucault's archaeology and genealogy is more complex than a progression or a binary. Foucault did not repudiate his archaeological studies (2001a, 2001b, 2003). In *Archaeology of Knowledge* (2002) Foucault is clear on two points. First is about questioning familiar boundaries, categories, groups and divisions. He writes: "Unities that must be suspended above all are those that emerge in the most immediate way" (ibid., p. 25). The second is about following the data and expecting surprises, "But it turns out that the difficult point of the analysis, and the one that demanded greatest attention , was not the same in each case." (ibid. p.72). In TEL research the obvious unities are 'technology', 'enhancement' and 'learning'. To suspend these unities is to examine how they come to be unities. In other words, research involves examining the work that produces the unities including the assumptions,

judgements, controversies, forms of analysis, debates, agreements and disagreements.

So far in this review I have circled around the notion of Foucauldian discourse and discourse analysis and yet both of these are central to the work in this thesis. Drawing on Foucault's writing and empirical studies described so far, the notion of discourse can be understood in a quite specific way. Discourse refers to collections of statements which organise the way things are thought about and the possibility of action based on that thinking. In this way, discourse is knowledge about the world and things in it that shapes how things are done. Discourse frames what it is possible to think and do. In his early analysis Foucault describes discourse as a specialist language with its own rules, conventions and institutions in which the discourse is *produced* and *circulated*, and which *authorise* and *legitimate* the discourse (ibid. 2003). Discourse produces human subjectivities, archives of knowledge, and material things like physical text, buildings and technologies (ibid. 1995). TEL discourse is an example of such a discourse. TEL discourse has a specialist language which produces particular forms of knowledge (note the image at the beginning of this chapter). There are professional bodies and social spaces within which the TEL discourse circulates (e.g. schools and universities and online spaces). This discourse produces subject positions like researchers, professors, designers, learners, teachers, and learning technologists; and it is reproduced in architecture and in the design of computers, digital artefacts, and digital information and communication services.

Discourses are articulated through myriads of visual and verbal images, technical artefacts, documents and other writings (both specialist and general), and through the practices that these articulations allow. This is evident in the breadth of materials that Foucault references in his empirical studies (1995, 2001a, 2001b). Responses to the *What is TEL research?* and *"Where does it come from*? will come from discourse analysis of different kinds of text and representations. For example, a technical artefact like a computer has functionality which is described

in manuals. Software applications are code and representations of data which are texts that can be digitally processed and stored.

As noted before Foucault rejects analysis that looks within, behind, underneath or in some other way seeks to explain in essentialist terms. Foucauldian notion of causality and dependency as such is polymorphous. Foucauldian discourse analysis involves working with materials to generate descriptions which he describes as a " 'polyhedron' of intelligibility, the number of whose faces is not given in advance and can never properly be taken as finite." (ibid. 1991, p.73) In other words examining relations between materials, is a way of excavating what Foucault (2002) calls *discursive formations*, and *regularities*[9]. Regularities are an important concept in this thesis. This is because the concept captures the possibility of describing patterns that are persuasive examples of discourse but without the implication that these patterns are universal truth claims.

Discourse is productive in that it works to produce entities and relations that shape what a thing is, including TEL research. Foucault (2001, 2002) sees the productivity of discourse as a form of discipline and power. *Power* here is not the same as technological determinism, or human agency. Instead power is discourse, and discourse is everywhere and therefore so is power. As in the history of TEL, sometimes there are dominant institutions and social structures, and these are powerful in authorising and legitimising particular claims to truth. As Rose (2007) explains:

> The construction of claims to truth lies at the heart of the intersection of *power/knowledge* … Foucault insists that knowledge and power are imbricates one in the other, not only because all knowledge is discursive and all discourse is saturated with power, but because the most powerful discourses, in terms of the productiveness of social effects, depends on assumptions and claims that their knowledge is true. (p. 144, italics in the original)

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[9] These Foucauldian concepts blur boundaries between theory and method and are revisited in Chapter 3 and interpreted as methodological guidelines.

Foucault (1995) is clear that the grounds for claiming truth are "inscribed among the discourses of knowledge" (p.256), and the premise for exploring the discourse history of TEL research is that these grounds have shifted historically and this is undocumented.

Foucault has been criticised for rejecting the idea that knowledge can be discovered , while at the same time relying on making authoritative claims which imply the discovery of new knowledge in the relations between things (Callewaert, 2006). Moreover the empirical scope of Foucault's analysis (1995, 1997, 2001, 2003) is on a grand scale when he argues that the current conditions of possibility, what he calls the modern episteme, was established at the end of the 18th Century. The discourse history of TEL research may be a part of this larger narrative, but this thesis is concerned with the particular and specific history of *What is TEL research?* and *Where does it come from?* The particular and the specific history of TEL research is distributed across continents, but importantly includes the construction of material objects, where discourse is embodied in digital artefacts, transported across time and space, and difficult to reverse. This means that discourse analysis has to be interpreted for the specific purpose of examining *What is TEL research?* and *Where does it come from?* To do this, the inquiry in this thesis turns to resources from actor-network theory that are about the socio-material construction of realities, and about tracing the specific and particular of discursive constructions.

Foucault and his interpreters recognise the endless productivity, variety and creativity within the existing conditions of possibility (cf. Foucault 1974, 1980; Rose 2007), and this is also true of actor-network theory. Actor-network theory emerged in the early 1980s at the Centre de Sociologie de l'Innovation de l'École Nationale Supérieure des Mines de Paris. Associated with science and technology studies and the work of Michel Callon (1986), Bruno Latour (1999) and John Law (1991), actor-network theorists pioneered non-deterministic inquiry by developing a rich set of material-semiotic tools, methods, and sensibilities (Fenwick & Edwards, 2010). Law (2004) describes actor-network theory as:

an approach to sociotechnical analysis that treats entities and materialities as enacted and relational effects, and explores the configuration and reconfiguration of those relations. Its relationality means that major ontological categories (for instance 'technology' and 'society', or 'human' and 'non-human') are treated as effects or outcomes, rather than explanatory resources. (p. 157)

What is clear from this definition is that nothing exists prior to its *performance* or *enactment*. In this interpretation of non-deterministic inquiry, the objective is to describe the *work* involved in how things come together in *gatherings*, *assemblages* and in general *networks*. This is because all entities and phenomena are relational effects of these alliances, including *what TEL research is*. Actor-network theory characterises the implications of these precepts for research practice in two concepts:

- "Free associations" (Latour & Diego 1996, p.9), because *what* things come together, and *when*, is indeterminate before it happens.

- "Generalised symmetry" (ibid., p.15), because all entities carry the potential to make connections and exert effect, and the entities can be anything: knowledge, identities, routines, technologies, code, curricula, friendship, rivalry, and more. The stuff that can join and exert force is endless.

In empirical studies, actor-network theory has taken a wide range of inconsistent forms and been criticised on many fronts. For example Fenwick & Edwards point out that: "The frustration expressed by the most prominent ANT commentators is that many early ANT studies reified concepts such as networks, solidified particular models of analysis and colonized their object of inquiry in representational ways that ANT approaches were intended to disrupt." (2010, p. xi). Critics note that actor-network studies have a tendency to focus on the most powerful and visible networks (Whittle, 2008), or to reframe complex vocabulary into a fixed model (Law & Hassard, 1999). Actor-network theory has also been criticised for refusing to base its explanation of change on ontological categories

generally accepted in sciences and social sciences, although less so in the humanities and philosophy. As Law (2004) puts it: "The extent to which these complaints are appropriate to either early or contemporary work is a matter of judgement" (p. 157). My response in this thesis is to rely on original (rather than secondary) texts on actor network theory methods, and to work from these texts to translate sensibilities into an inquiry process (Latour 2005; Law 2004).

A number of writers have noted Foucauldian influences in actor-network theory, particularly in literary analyses of texts (Kendall & Wickham 1999; Sismondo 2009). Asdal et al. (2007) describe how Science and Technology Studies and actor-network theory emerged as a critique of Sociology of Scientific Knowledge (SSK), and note:

> Both SSK [Sociology of Scientific Knowledge] and Foucault emphasize the productive and enabling aspects of power [but] science and science studies inspired by Foucault, including the new laboratory studies, goes further than SSK in its understanding of practices, including scientific and technological practices, as materially productive and effective.(p. 27)

Latour (2005) has shown that the processes and forces of constructing the 'real' or 'reality' leave traces. Without these traces, there is no performativity, there is no construction of things, nothing is going on. Traces are material and semiotic, they are inscribed and enacted in text, images, media and technologies. What Foucault describes as statements and inter-textual references are comparable to traces. Both can be understood as enactments of discourse.

Foucault describes the productivity of discourse and recognises the uncertain trajectories of change and transformation when he writes about discontinuities, raptures, gaps, and sudden redistributions (2002, pp. 185-188). Law et al, (2013) and Latour (2014) develop a similar line of reasoning in describing the productivity of discourse in conditions of uncertainty. A detailed account of how this productivity works was published by Latour in 1993 in his, now classic, text

We have never been modern. The three parts of his argument are the three parts of non-deterministic inquiry that are developed in this thesis.

First, Latour says modernity presents itself as *coherent*, consistent and complete. He calls this *purification*. Invisible infrastructure and services like the internet, and everyday objects like mobile phones are examples of purifications. These devices, our private messages and searches, how they look and feel, where they are put, and take us, the smoothness of surfaces, the ergonomic curves and lines, these are experienced as the fabric of being modern. There is nothing fuzzy about this, modernity is self-evident as progress pure and simple.

The second part of the argument is that in practice purification is not pure at all, is a *hybrids* of relations between things which are a messy mishmash of accidents and controversies. TEL research for example is a series of stop-start stories, different systems, different standards, different ideals, and funding regimes; but this does not add up to 'incoherence'. Law (2011) calls it "non-coherence" (p.1). He writes, "*Modernity is a both-and*. It's both pure, and it isn't pure at all" (Law et al. 2011, p. 2 italics in the original). This captures the uncertainties, and the *multiplicity* of partially connected discourses. Law (2011) and Latour (1993, 2005) are saying that the production of knowledge and things is a messy, uncertain process and has always been so.

The third part of the argument is about *performativity*, in other words the productive effects of both the will to *purity (coherence),* and inevitability of messy *hybrids (non-coherence).* As new TEL research is funded and new technologies come onto the market so the material realities are changing and affecting how learning is thought about and enacted. The proposition is that different *logics* (also called modes or forms of ordering) are always at work, and these are comparable to Foucauldian discourse regularities.

While Foucauldian discourse analysis has influenced many empirical studies which combine textual and visual data (Rose 2007), it is less visible in studies of

TEL research. Actor-network theory is evident in socio-material studies in education (e.g. Fenwick et al. 2011); in ethnographical case studies of TEL research (Sørensen 2009; Rimpiläinen 2012); and in critique of TEL research (Wright & Parchoma 2011). However, to date actor-network theory has not been mobilised to trace the discourse history of TEL research.

Gathering key constructs. From this review, it is proposed that concepts from actor-network theory can extend Foucauldian focus on discourse in three ways by exploring: (1) how discourse is materialised in the design of digital artefacts; (2) how discourse is changed by translation; and (3) the productivity of discourse in conditions of messy enactments. What each part entails needs some explanation:

(1) The proposal here is that ubiquitous technologies are stabilisations of discourse, and that this discourse carries network of relations across time and space. This is discourse embodied in the machine and, in this thesis, this is called materialisation. Actor-network theorists have a well-developed vocabulary that can be mobilised to understand materialisation. For example, black boxing is when the work involved in producing an object is rendered invisible so that it has no visible history. Stabilisation is when the effects of particular assemblages of people, ideas, resources, finance and so forth, is so well developed that it is difficult to reverse. A related concept, immutable mobiles or forms, allows a set of relations to be transported from one place to another. It is comparable to the idea of regularities in Foucauldian discourse but extended to what is carried in the design of digital technologies.

(2) Actor-network theory has been described as the 'sociology of translations' (Callon 1986, p.1). Translation describes what happens when entities – human and non-human – act on each other to form successful associations. Change conceptualised as translation is non-deterministic because what happens when things come together is not wholly predictable. An alliance might come about by negotiation, subjugation, seduction, violence, persuasion and many other ways, but when translation takes place there is a new discourse configuration until the

next translation. In other words: "When translation has succeeded, the entity that is being worked upon is mobilised to assume a particular role and perform knowledge in a particular way. It performs as an actor" (Fenwick & Edwards 2012, p. xii). Actors are things that act in the world with some autonomy. It can be the curriculum (Edwards 2012), scallops in the sea (Callon 1986), or milk (Nimmo 2011). It can also be a whole network that is reduced to a node in another network, and this is referred to as punctualisation (Callon 1991).

(3)   Foucauldian discourse analysis recognises that objects of discourse, including knowledge are contingent and messy (Foucault 1991, 2002; McHoul & Grace 2015). Actor-network theory has developed concepts for describing the productivity of discourse in conditions where coherence and non-coherence are both inevitable. Law (2004) writes: "What happens when social sciences tries to describe things that are complex, diffuse and messy? The answer … is that it tends to make a mess of it. This is because simple clear descriptions don't work if what they are describing is not itself very coherent. The very attempt to be clear simply increases the mess" (p. 2).

Having introduced conceptual resources from Foucault and actor-network theory the discussion now turns to what this means in terms of new knowledge and why this matters.

Matter of new knowledge. Part of the 'common sense' of TEL research funding is that it should be relevant to the needs of practice and contribute to improvement (Moody & Buist 1999; Barry et al. 2009). The term 'enhancement' is an equivalent of the more prosaic term 'improvement' and both are about different ways of knowing so that we can teach better, learn better, design better technology, and generally bring about change for the better. This dominant concern with 'improvement' is an integral feature of funded TEL research in many post-industrial countries (Kember 2007). This normative tendency to frame what is to be done in terms of universal truths and natural 'goods' is problematised by Foucault (2002), Law (2004) and Latour (2005).

So far in, in this chapter, the differences between actor-network theorists (Law & Hassard 1999), and debates around different readings of Foucault (Fejes & Nicoll 2008) have been noted but not laboured. However, with regard to normativity it is worth considering Latour, Law and Foucault separately.

Taking Latour first, his argument is that considerations of normativity, what he calls political relevance, should come *after* the empirical work. He writes:

> Positivism – in its natural or social form, in its reactionary or progressive form – is not wrong because it forgets 'humans consciousness' and decides to stick with 'cold data'. It is wrong politically. It has reduced matters of concern to matters of fact *too fast, without due process.* (Latour 2005, p. 256, italics in the original).

Following due process means doing the empirically painstakingly slow work of tracing socio-material assemblages of how things are constructed into being 'real'. In Latour's argument, normative considerations come after this because the prior work of how the real is constructed allows informed critique. For Latour the political challenge is to contribute better, more relevant studies of science and social science so that informed interventions are possible (Asdal et al. 2007).

Law's writing on normativities takes relativity to its logical conclusions. Like Latour he emphasises the uncertainty of inquiry, but he goes further in formalising this as 'mess'. Law is keen to characterise the productivity of coherence and non-coherence, but, "[this] does not work on the bases of whim or violation. It needs to resonate in and through an extended and materially heterogeneous set of patterned relations if it is to manifest a reality and a presence that relates to that reality" (Law 2004, p. 148). As with Latour, there is an emphasis on empirical work, but in drawing conclusions Law stays close to the specificity of time and place. For Law, normativity calls for ongoing interrogations of the particular and the specific and case-by-case judgements.

Foucault comes to normativity through the subject. He wants to understand the discourses that produce particular subjectivities, and make other subjectivities and identities more difficult or out of the question (Foucault, 1991). Writing about the consequences of Foucauldian analysis of lifelong learning, Biesta (2008) shows that while the pattern of analysis is similar across different studies[10], normative implications can be framed in quite different ways. Biesta describes three positions adopted across a spectrum of Foucauldian scholars. First, some scholars are explicit in their conclusions and recommendations (Popkewitz 2008; Fejes 2008). They emphasize the emancipatory potential of Foucauldian analysis to reveal the workings of power and to empower individuals to challenge it. Second, there are scholars who present their analysis in some detail but refrain from making explicit inferences. Analysis is staged in the spirit of 'look what is going on here' (Olsson & Petersson 2008; Solomon 2008). The third position is about decentring the self-evident so that what is produced is not guidelines or instructions or anything that might interest reformers or social workers (Biesta 2008; Nicoll 2008). Instead there is a deliberate effort to unsettle. Biesta (2008) captures this by combining his words with a quote from Foucault (1991, p. 84):

> people "no long know what they do", so that the acts, gestures, discourse which up until then had seemed to go without saying become problematic, difficult, dangerous – and this effect is entirely intentional. (p. 200)

These arguments about normativity share an emphasis on detailed empirical analysis that is inseparable from relational conceptual resources. The final chapter in this thesis returns to these different understandings of normativity, and contributing to new knowledge.

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[10] Biesta works with studies in an edited volume that includes articles by Edwards, Olssem, Simons and Masschelein, Olsson and Petersson, Popkewitz, Fejes, Assarsson, Zackrisson and Assarsson, Berglund, Ahl, Nicoll, and Solomon (Fejes & Nicoll, 2008)

Configuring the inquiry

The conceptual resources described in the previous section advocate non-reductive explanations, drawing as they do on Foucault, Law and Latour. Configuring the inquiry is about setting up an empirical inquiry that both allows multiplicity and ambivalence but also provides some answers to the questions *What is TEL research?* and *Where does it come from?* Methodologically this is about *making decisions* on how to mobilise the conceptual resources to inform the process of data gathering, analysis, writing and structuring the thesis. These decisions frame the scope of the inquiry and are discussed next.

The first problem is where to start and what to focus on. There are some practical problems in doing non-deterministic inquiry that assumes the possibility of free association between all entities. If all things can be potentially connected then the connections between things are potentially infinite. Miettinen (1999) sees this as unworkable for researchers, but Strathern (1996) sees it as a problem for all research, i.e. the question of when to stop, which she describes as *"Cutting the network"* (p. 1). This problem is not insurmountable, and Fenwick et al. (2011) have documented a number of useful studies that are methodologically aligned to actor-network theory and cover broad areas like 'policy and politics in education' (cf. Waltz 2006; Hunter & Swan 2007; Mulcahy 2012), and 'what constitutes learning and change' (cf. Fox 2005; Verran 2007; Gough 2004). These studies trace networks of connections which transgress boundaries and they do so using techniques from ethnography, case studies and documentary analysis (cf. Fenwick & Edwards 2010; Fenwick et al. 2011).

Scoping techniques help to identify a beginning and set constraints on the space of inquiry, such as, the length of the project (Hamilton 2012), the time researchers spend in situ (Mol 2002), and access to documentary material and other data (Gorur 2012). In some studies the role of 'a token' is important (cf. Edwards 2012; Rimpiläinen 2012). In actor-network theory, a token can be a discourse, an object, an entity; in fact it can be anything that is recognised as a category. The

researcher then follows the token, documenting how it is taken up or ignored, and translated through association with other entities. Tokens allow focus, but undermine reduction and this is because "tokens are always unfinished and there are patterns of possibilities that can be inscribed into them and that they inscribe in others" (Edwards 2012, p. 29). The token can also be traced to understand its own emergence and effect. These possibilities have influenced how the research is configured in this thesis in the following ways:

- *Settling on a beginning*. To do this I return to the time and place and documents that triggered puzzlement over what 'TEL research is and where it comes from', namely the TEL call for funding document (2006, 2007). This is a vantage point from which to look backwards and forwards in time.

- *Focus*. Since TEL has been known by many names, 'technology', 'enhancement' and 'learning' present themselves as three tokens that can be traced into the past and the future after they first appeared together in the TEL call for funding document.

To write a discourse history it is necessary to examine materials over a period of time. Foucauldian discourse has influenced many empirical studies which analyse textual and visual data archives (Rose 2007; Nead 2000). A way forward is to settle on an historical/archival inquiry which combines Foucauldian discourse analysis with insights from actor-network theory studies. In other words, an historical analysis which follows the three tokens, 'technology', 'enhancement' and 'learning', by tracing them across archived materials that include text, multimedia and artefacts of digital technology. It has turned out that while there is a lot of material relating to all three tokens, there are no established archives of 'TEL history' and so a significant portion of research time was spent gathering data from heterogeneous archives.

The empirical work of assembling heterogeneous collections of TEL history is timely, but there is a danger, as Kendall and Wickham (1999) warn, of settling history into a "path of imagined sensibleness in the field of strangeness" (p. 4).

Derrida (1998) provides a theorised commentary on archives which articulates the open-ended productivity of assembling and working with archives: "The technical structure of the archiving archive also determines the structure of the archivable content even in its very coming into existence and in its relationship to the future" (p. 17). Steedman (2002) describes this as historical research into institutions of archives, the practices of reading and writing attendant on selecting, storing, annotation, regulation, coercion and so forth. This is not to suggest that the archive is a neutral account of history (Geiger et al. 1999, Manoff 2004). The empirical research ahead will include the online field work of gathering data, and the conceptual work of stabilising the archive with the space of this thesis. To the two previous configuration points I can now add a third:

- *Archives.* This refers to searching archives and working with digital capture, storage and classification tools to compile mixed-media materials and catalogue a portion of this material. A starting point for this was the TEL call for funding documents, which were used to trace the tokens backwards in time to 1945, and up to the end of the TEL Programme in 2012.

In Foucault's (2002) *Archaeology of Knowledge,* the archive does not stand for what can and cannot be said. It is rather "the system that establishes statements as events and things" (p. 79). Foucault described "discourses as practices specified in the elements of the archive" (p. 131) and archives as "the general system of the formation and transformation of the statements" (p. 130). It is to tackle the contingencies around what is lost, preserved and found, and to find some closure (but only in the space of this inquiry) that part of the work of this thesis is to investigate existing archives and assemble collections of TEL history. What this involves is looking into archives that are not usually associated with TEL history but are nevertheless part of the *surfaces* of *emergence* (Foucault 2002, p. 45). In other words *Where TEL research comes from.* This means that I can now add a fourth configuration point:

- *Collections.* This means organising the materials gathered from the archives into collections that mark discursive shifts in understanding 'what TEL is and where it comes from'.

As with assembling data, the activities of analysis and writing are also open to endless possibilities for inclusion of associations between things. There are many technologies, theories of learning, TEL methods, application domains, TEL research projects, and a growing number of TEL researchers. To control this messy space I analyse methods text from Foucault (2002), Latour (2005) and Law (2004), and from this develop some guidelines for data analysis. This is the fifth and final configuration point.

- *Analysis.* By interpreting methods text on non-deterministic inquiry from Foucault, Latour and Law, develop guidelines for close analysis of materials in the collections, and presentation of findings.

Configuring the inquiry in this way suggested an inquiry plan that is both non-determinate but also moves towards some preliminary conclusions within the space of this thesis. This involves aligning the collections (sets of materials), to the tokens (i.e. 'technology', 'learning' and 'enhancement'), the problematic (i.e. how discourse of TEL works, changes and is both productive and messy). This is the plan for research enactment in this thesis.

Whereas the stated aim of this thesis is to empirically examine the discourse history of TEL research and to understand *what is TEL research* and *where it comes from*, it is also an experiment which combines Foucauldian discourse analysis with sensibilities from actor-network theory. In the final chapter, I review the work in this thesis and make judgements about what has been achieved in terms of new knowledge, who might be interested, and why it matters.

Organisation of the thesis

This chapter started with some seemingly obvious questions – *What is TEL research?* and *Where does it come from?* – and it explored the uncertainty around straightforward responses to these questions. I then described a history of TEL research as a series of uneven interruptions rather than a smooth narrative of progress. The questions were then set up as a problematic of non-deterministic inquiry, more specifically about writing a discourse history of TEL research by drawing on conceptual resources particularly from Foucault (2002) and from actor-network theorists Latour (2005) and Law (2004). Configuring the inquiry by drawing on resources that are not usually mobilised in TEL research, opens up the possibility of generating new understanding and knowledge, and interpreting new ways of making a difference to practice.

Following on from this introductory chapter:

Chapter 2 is a literature review of publications about TEL as a field of inquiry. The aim here is to see if there is other research about the discourse history of TEL research that asks similar research questions and draws on non-deterministic forms of research. I characterise the gaps in relation to my research questions and non-deterministic inquiry processes.

Chapter 3 is the methodology chapter. It is about the process of inquiry. This chapter asserts that the discourse history of TEL needs to include accounts of discursive shifts (Foucault), entities that start off as uncertain and are translated into being (Latour), and the forms of ordering that allow many coexisting discourses and (un)certain entities (Law). The writings of these three authors are interpreted into guidelines for data collection, analysis and reporting. These are then used to describe a beginning (called a vantage point), and for creating an archive that is divided into collections of data. The chapter ends by setting out a plan for organising a discourse history of TEL research that provides some

responses to the research questions *What is TEL research?* and *Where does it come from?*

Chapters 4, 5, and 6. These three chapters do the substantive work of the thesis. Each chapter starts by introducing the relevant archives and collections which are the focus of analysis. This is followed by an analysis from the vantage point of the TEL call for funding documents (2006, 2007). Chapter 4 looks at the discursive construction of 'technology', Chapter 5 at 'learning', and Chapter 6 at 'enhancement'. Each chapter follows the action in a different way. Chapter 4 describes the discourse from engineering and how this is *materialised* in the digital technology and learning design. Chapter 5 traces the expansion of TEL networks beyond the academy e.g. in the advent of e-learning in industry and commerce. This is a history of vested interests and struggles over what counts as 'learning'. In this affray, constructions of learning are described as a series of *translation effects* which enact coherence. Chapter 6 describes the *forms of ordering* that make action possible when TEL research is enacted as both coherent and non-coherent. This is about how differences and partial connections are managed and regulated and performed into coherence.

Chapter 7 This final chapter starts by recapping the considerations that triggered the problematic of the thesis and the starting point of the journey. At this stage in the thesis, TEL research will have been encountered through non-deterministic resources and, in the process, drawn on Foucault, Law and Latour for exploring the history of TEL research. In summarising the inquiry process I argue that Foucault, Law and Latour are productive influences that are new in TEL research. Following this, I discuss the contribution of this thesis in relation to my research questions *What is TEL research?* and *Where does it come from?* The chapter ends with some speculative last words on some bodies of knowledge that this thesis can claim to have contributed to, and why it matters.

Note to the reader It will become evident as this thesis unfolds that the discourse history of TEL research is scattered across a number of formal and informal

databases, online museums, archived internet sites, and TEL project websites. The empirical data in this thesis is drawn from this pool of materials about TEL research from 1945 to 2012. This note to the reader draws attention to two tactical decisions that this entailed. First the gathering of data involved assembling an archive of materials. In practical terms this archive is a combination of materials imported into a proprietary qualitative data analysis software tool called NVivo 10; and meta data records stored in an open source referencing tool called Mendeley 1.15.2. Outside of the work in this thesis, this 'The Discourse History of TEL Research 1945-2012' archive will be transferred to a database and lodged in the UTS library. Second, the reader will note that the UTS system of citation and referencing is used to reference data materials including web links. These links were reviewed in November 2015 but overtime some may disappear. In anticipation copies of all the referenced materials have been harvested and will be transferred to the 'The Discourse History of TEL Research 1945-2012' archive database.

Chapter Two: Accounts of 'Technology Enhanced Learning' (TEL) Research

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We must question those divisions or groupings with which we have become so familiar. Can one accept, as such, the distinction between the major types of discourse, or that between such forms or genres as science, literature, philosophy, religion, history, fiction, etc.? (Foucault 2002, p. 24)

Introduction

This chapter is a review of the literature on TEL as a field of inquiry. Chapter 1 introduced TEL research through literatures that are not usually considered together. It described the uncertainties experienced by researchers in the field, and how 'uncertainty' has been explored in other literatures that are aligned to non-deterministic forms of inquiry. Drawing on these resources I made the case for paying attention the *work* involved in constructions of TEL research past and present (i.e. how it has come to be what it is); tracing how change takes place and becomes difficult to reverse; and examining the *productivity* of practices when TEL research is uncertain and messy. This is a way of understanding the gaps in the TEL literature. This chapter examines how scholars and professionals in the field engage with the questions *What is TEL? and Where does it come from?* It highlights the impulse towards *certainty* in the mainstream of TEL literature and the acknowledges insights from the extant TEL literature that has an intellectual commitment to *uncertainty*.

This chapter is organised in three sections. They are:

- *TEL as a field of inquiry*. This extended section is about how an outsider knows that there is such a field of inquiry. This reviews the divisions and groupings that are familiar, and groupings that are in ascendance and in decline.

- *Locating a vantage point.* This section leads to the TEL call for funding documents (2006, 2007), in which the phrase Technology Enhanced Learning

appeared for the first time in the UK. Building on the discussion in Chapter 1, this set of documents is located as the analytical, and historical starting point for the research in this thesis.

- *Configuring the gaps.* Throughout this chapter, I draw attention to gaps in the literature. This final section acknowledges some possible misunderstandings that might arise from this, and returns the focus to the idea of construction as 'work' that can be empirically investigated.

TEL as a field of inquiry

The section on TEL(ling) history in Chapter 1 introduced the idea that the concept of TEL at any particular time and place has a history. In 2006 Czerniewicz asserted: "Although there is some general consensus that the field exists, its nascent state is evident in the lack of agreement about its name." (2008, p.171). Clearly TEL[11], is known by many names and the implications of what this might mean or imply has been explored by TEL researchers (Czerniewicz et al. 2006, Moll et al. 2007). Part of the argument that the field exists is that TEL researchers self-identify their affiliation to this field, examples being Conole et. al. 2004, and Jones 2004 (UK): Januszewski 2001, and Luppicini 2005 (US); Coutinho and Gomes 2006 (Portugal): Graells 2004 (Spain); Czerniewicz et al. 2006 (South Africa); and Alexander et al. 2006 (Australia). This gathering of interests, forging of alliances, and declarations of consensus suggests that the field has some stability, and indeed there is a literature which addresses the question *What is TEL research as a field of inquiry?*.

This section reviews the literature to learn about what TEL scholars and professionals say their field is about. Answers to these questions take various forms:

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[11] Computers in Education; Computer-Based Training (CBT);Internet-Based Training (IBT); Web-Based Training (WBT); Web based learning (WBL); Computer-based learning (CBL); Virtual educating (VE);Instructional Design (ID); Computer-supported collaborative learning (CSCL); Computer supported group learning (CSGL); Mobile learning (ML); Network learning (NL); Advanced distributed learning (ADL) Open and distance education (ODL); Virtual Learning Environment (VLE); Managed Learning Environment (MLE); Online distance Learning (ODL); e-learning; Network Learning; Telelearning; Instructional Design and Telematics.

- TEL research as technologies. This literature reviews the different constructions of 'technology' in TEL research including 'technology' as an object of research, and 'technology' as a finished object that is used as a resource for TEL research.

- TEL as content. This literature is focused on finding consensus and consistency amongst TEL researchers on what counts as TEL topics and problems.

- TEL as self-differentiated communities, including well-established and regulated communities, and clusters of research interests. These groups are marked by established journals, conferences, key texts, research groups and champions. Some are associated with professional bodies.

- TEL as a profession. Here TEL research is associated with professional bodies, for example in the UK, *The Association of Learning Technology* (ALT), and funded research that is expected to inform practice and influence policy.

- TEL in policy narrative is about accounts of TEL as a field of inquiry that enact politics in the UK. This returns to the European/UK rebranding of TEL as an applied field with accountabilities, as was described in Chapter 1.

- TEL as forms of knowledge reviews the differences in conceptual orientation that are evident in accounts of TEL research.

The review examines what is written about where TEL comes from; how an outsider knows that there is a field of TEL and draws attention to the gaps in the literature.

TEL and technologies

A number of articles in the TEL literature are about software applications and digital artefacts deployed in learning environments. Much of this literature is referenced in a report about the findings from UK TEL Research Programme, *Beyond Prototypes: Enabling innovation in technology-enhanced learning* (Noss et al. 2013). The report tells us that TEL research "focuses on how technologies can add value to learning and teaching processes" (p. 12), and goes on to state that technology enhanced learning, is the preferred term for researchers working in the area (compared with 'e-learning', for example). The reason given is that this "stresses that the technology is

employed in service of learning, and that it is not just adopted, but expected to deliver improvements" (p. 12). Here is a chicken-and-egg situation. TEL purports to research 'technology' , yet 'technology' is also taken as a given object as described content of TEL (this is discussed later in this section). Many TEL researchers are well aware that technology is not neutral, that there is agency embodied in the machine (Kaptelinin & Nardi 2006). Noss (2012) has argued that technology is about 'learning the unlearnable*', but that we don't teach the knowledge and skills that open the black box of technology to scrutinise the models that are encoded in software.

The situation is further complicated because 'technology', as a category, is a simplification that hides the differences between various digital technologies. The types of digital technologies that learners can access, is catalogued in the *Beyond Prototypes Report* (2013), and a number of other publications (cf. Crook & Harrison 2008; Hayes 2015; Lally et al. 2011; Laurillard 2002; Mayes et al. 2009; Sharples et al. 2009.). for example:

- increasingly powerful devices, including smartphones, games consoles and digital tablet devices

- digital technology for sharing, interaction and immersion online through social networks and virtual worlds

- analytics that can capture user activity and feedback in real-time

- simulation technology that can model complex worlds and allow the user to experiment and design

- representational technology allows new forms of literacy, problem solving, collaboration, creativity, and publication to external audiences.

In these accounts, TEL as a field of inquiry involves interpreting education broadly, and teaching and learning in particular ways, in relation to the affordances of digital technology. For example, in some TEL research, education is a media production of learning objects in massive open online courses (MOOCs) (Hayes 2015). Some researchers condense theories of learning and then analytically map these to

technology affordances (Mayes et al 2009). Other research of this type interprets the conversation theory of learning (Pask 1980) to model the dialogue between the teacher and learner. Affordances of particular digital technologies are then mapped to pedagogical opportunity for feedback, explanation, experience and assessment (Laurillard 2002).

Furthermore, accounts of TEL as a field of inquiry simplify the emergence of digital technology by describing these as inventions or innovations. The chronological citations of innovation in *Beyond Prototypes* (2013) are typical: from Skinners teaching machines (1958) to Engelbart's designs for augmenting human intellect (1962); from the dynabook imagined by Alan Kay (1977) to Papert and his Mindstorm robot building kit (1993); from Tim Berners Lee and his hypertext programme Enquire and eventually the World Wide Web (2000) to Negroponte's technology for wider use and the One Laptop Per Child project (2007). Typically, this history is presented as background and summarised in a time line (see also Conole & Oliver 2007, p. 58)

According to this literature, an outsider knows they are in the field of TEL when affordances of digital technologies guides recommendations for pedagogy. This seems to be the case in the *Beyond Prototypes* Report (2013), even when there is a self-conscious effort to avoid analysis that is technology led, or to suggest that technology innovation is a "smooth progression" (2013, p. 18). Furthermore, attention is paid to 'learning' and 'enhancement', but often the 'technology' is treated as a given. In other words, technology is regarded as a series of black boxes with intrinsic affordances, and this is evident in the history of technology being described as background or context. This has the effect of allowing only ahistorical questions, for example: "What will be the impact of emergent mobile and smart technologies?" or "What platforms are being used and how do they compare?" (Conole and Oliver 2007, p18). A different type of question to this is: How did technology come to be as it is? In other words: How are affordances materialised? Starting from the premise that technologies are socio-material constructions, there is

scope for research that traces the discourse(s) materialised in the technology, and how this has come to be invisible and difficult to reverse.

TEL as content

The majority of articles about TEL as a field of inquiry can be described as content reviews. These seek to discover and catalogue themes, problems, theories and topics which define the field. TEL literatures that are broadly about content seek to specify what it is. In the literature there are at least two different approaches to defining TEL in terms of content. One is based on the researchers academic judgement and involves describing patterns using various analysis and synthesis strategies. The other involves writing software to automate the process of classifying the content publications about TEL research. Referred to as the judgement approach and the algorithmic approach, these are discussed next.

The academic judgement approach is broadly concerned with synthesising from TEL literature, where the materials included (e.g. review papers and reports) are based on judgements made by researchers and authors. Judgements are sometimes based on criteria for determining relevance and importance, and deciding what is included and excluded. Sometimes the quality of the judgement is implied by the authority of the authors and their institutional affiliations. For example, the widely cited study, *e-Learning research: emerging issues? (*Beetham 2005)*,* was originally commissioned by the Joint Information Systems Committee (JISC) and later published in the Association for Learning Technology journal, *Research in Learning Technology*. In 2005, the target audience for the ALT journal was the emerging profession of Learning Technologists.

Notably, judgement-based reviews provide a rationale for agenda-setting articles (cf. Beetham 2004; Czerniewicz 2008, 2010). What is striking is that they are a mixed bag that includes: grand agenda challenges (e.g. Taylor et al. 2004); studies based on expert judgement (Kirkwood & Price 2013; Pollard & Pollard 2005); collective

working papers from the Europe TEL network (Ballachef 2006) and international literature reviews (e.g. Attwell & Hughes 2010).

In her analysis of these judgement-based reviews, Czerniewicz (2010) makes the point: "Interestingly learning issues are unanimously the key theme mentioned in both research reviews and priorities, in contrast to the perception that the field's focus is technological" (p. 528). She highlights six themes in TEL research, which are corroborated by the other publications shown:

- Collaborative learning (Tu & Twu 2002; de Laat et al. 2006)

- Learning: Informal/non-traditional learning (Hedberg & McNamara 2002; Taylor et al. 2004; Ballachef 2006)

- Assessment and evaluation (Beetham 2005; Pollard & Pollard 2005)

- Teacher–student relationship (de Laat et al. 2006; Pollard & Pollard 2005)

- Diffusion and innovation (Hedberg & McNamara 2002; Beetham 2005; Ballachef 2006)

- Inclusion, access, accessibility (Taylor et al. 2004; Beetham 2005).

Czerniewicz notes the surprising emphasis on *learning* (rather than *technology*) is supported by earlier findings from Hedberg and McNamara (2002) in their review of TEL history in Australia. Yet Coffield (2007), a prominent commentator on research in education claims otherwise:

In all the pelting torrent of official documents which have flooded the sector since 1997, there is, however, one significant silence: there is no discussion of, and not even a definition[11] [sic.] of, the central concept of learning, although the word 'learning' is pervasive in such texts and deliberately used in preference to the term 'education'. And yet the whole programme of reform is dependent on some unstated notion of what constitutes learning, and especially, how we become better at learning. The implicit model is a simple input-output one....(p.18)

Coffield argues that it is not just definitions but also theory that is missing in policy documents (ibid.). His evidence demonstrates the disjuncture between TEL academic literature and policy literature which revolves around the black boxing of 'learning' in the latter.

This is interesting because technology and learning are inseparable in accounts of TEL research, even when the focus is on learning. This point is illustrated in three examples:

- Laurillard (2002) writes: "Having arrived at a perspective on learning and teaching that sees the process as essentially a dialogue," her next aim is to examine "what the various media have to offer learning and teaching" (p. 81). In these terms the 'TEL problem' is how to design, configure and deploy technology in the age of mass education.

- For Squires et al. (2000), the central question is: "How can institutional structures be modified to accommodate the possibilities afforded by technology?" (p. 2). In this the 'TEL problem' is again concerned with technology design, configuration and use.

- Prominent TEL researchers Dirckinck-Holmfeld et al. (2009) write: "The focus of our work is summed up in the term productive networked learning. We identify two central layers of concern in the promotion of productive networked learning, networked learning environments and design." (p. 7). Here the 'TEL problem' is concerned with technology environments and design.

These examples suggest that while it is true that TEL researchers emphasise *learning* rather than *technology*, the relationship between learning, technology and enhancement is perhaps more complex in TEL research than currently documented in content reviews of the field.

The second form of content review is based on an algorithmic approach, where researchers draws on tools, techniques and conventions from information science to

map the field of TEL research. In these reviews the emphasis is placed on automation and validity of methods that are independent of researchers' opinions. Literature that adopts more algorithmic strategies for mapping the field contrasts with that of the judgement approaches by drawing on statistical methods. Some of the quantitative techniques are quite intricate and involve calculation of significance rating which draw on AI weighing techniques (Chen & Lien 2011), and in some cases citation and co-citation analysis (Kirby et al. 2005; Dueber 2004). Two examples are described to give a sense of this enclave of activity and how that community understands TEL as a field of inquiry.

In one of the more straight forward examples, Shih, Feng and Tsai (2008) investigated research trends in the field of e-learning in relation to cognitive studies from 2001 to 2005 in five Social Science Citation Index (SSCI) journals[12]. Their question is 'What is e-learning research?', and they sought to answer this question by statistical analysis of journal articles that are classified as 'e-learning research'. To do this they identified 444 articles, then selected the 16 most cited articles for content analysis. They found that 'instructional approaches', 'information processing' and 'motivation' have "a greater impact on subsequent research" (p. 955). Within the 'instructional approaches' they found that 'collaborative learning' and 'problem-based learning' articles were most cited. They also report that in their study of researchers conducting e-learning research, questionnaires were the main method for gathering research data and there was a growing trend towards analysis of log files and online messages.

While algorithmic approaches to content analysis offer some interesting insights into research methods and publications in journals, the general argument is problematic. Shih et al. (2008) argued that their work validates "the constructivists' viewpoint that instructional models of collaborative and problem-based learning are essential in developing the constructivist framework for e-learning" (p. 956).

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[12] Computers and Education, British Journal of Educational Technology, Innovations in Education and Teaching International, Educational Technology Research & Development, and Journal of Computer Assisted Learning
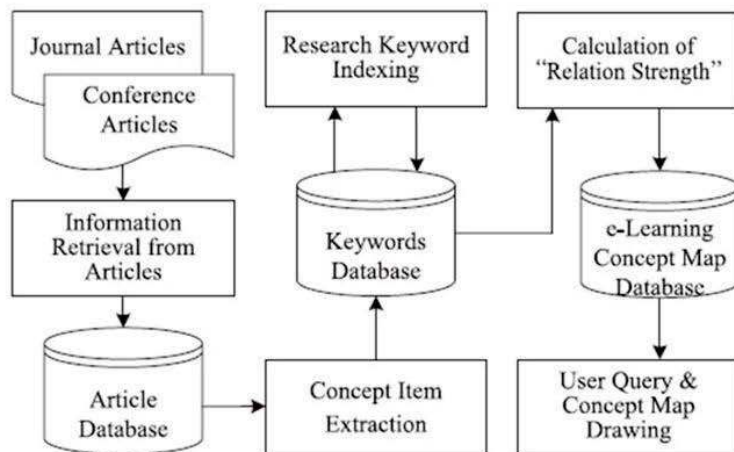
Procedure for constructing e-Learning domain concept map.

Table 2
The top 15 research keywords in e-Learning domain from 1999 to 2004

Rank	Keyword	Weight	Rank	Keyword	Weight
1	Information Technology (IT)	27238.50	9	Learning Technologies (LT)	2557.93
2	Intelligent Tutoring Systems (ITS)	6200.92	10	Higher Education	1649.58
3	World Wide Web (WWW)	4541.00	11	Computer Mediated Communications (CMC)	1625.32
4	Information and Communication Technologies (ICT)	3107.74	12	Distance Learning (DL)	1561.40
5	Web Based	3011.72	13	Learning Object Systems (LOS)	1428.60
6	On Line	2836.39	14	Problem Solving	1369.68
7	Collaborative Learning (CL)	2694.93	15	Learning Process	1107.98
8	Distance Education (DE)	2636.04			

Extract from Chen et al. (2008) illustrating the procedure for constructing e-learning domain concept map (p.1012); and a table of top 15 research keywords (p.1015)

Figure 2.1   Example of TEL defined by topics and key words.

However while algorithm-based approaches to content analysis may be seen as unpalatable within many social science traditions, it is never-the-less legitimised in that such work is regularly published in peer-reviewed journals (e.g. Chen et al. 2008; Chen & Lien 2011; Shih et al. 2008). Moreover, algorithmic approaches have epistemological and ontological affinity with TEL research into 'learning analytics', which uses many of the same techniques of data mining (Perrotta 2012; Sclater 2014).

Another form of the algorithm approach is typically located in e-learning research groups positioned in computer science. One line of inquiry involves experimenting with semi-automated concept mapping techniques for visualisation of complex information that are applied to the domain of e-learning. The idea is that dynamic concept mapping can reduce problems associated with overload and disorientation in large information spaces (Chen et al. 2008). Chen et al. argue that domain knowledge modelling by human experts is expensive and time consuming and so it is desirable to automate text mining to generate a domain map of e-learning. Their reasoning comes from knowledge elicitation and modelling techniques pioneered by knowledge engineers working on expert systems in the 1990s (McFarland & Parker 1990). Developing an expert system is a long, expensive process and involves many years of working with domain experts to model the domain knowledge. This is the rationale for automating the process of mapping domain knowledge. The aim is therefore to build a software application, and then use the technology to build a concept map of the field of e-learning.

Concept maps typically include tools for organizing and representing knowledge and "graphical representation where nodes represent concepts and links represent the relationships between concepts" (Plotnick 1997, p. 1). Chen et al. (2008) note that concept mapping is the first step in ontology building that can represent the structure of knowledge in any domain, including e-learning. This computer science language is part of a specialist discourse where ontologies are made by programmes and tested for utility and performance within the code. Figure 2.1 shows a schematic view of the system used to generate concept maps and a list of keywords produced by algorithm. This figure is taken from Chen et al. (2008). At the top is a schematic view of the procedure for extracting e-learning domain concept map (p. 2012). The research claims that the frequency of key words identifies important TEL research topics, (shown below the schematic in figure 2.1).

The review of algorithmic procedures offers insight into particular forms of research practice applied to e-learning. It is interesting that the algorithm is invoked to both legitimise and generate this particular list of categories and relationships. Much

human and machine endeavour goes into making algorithmic approaches productive and these semi-automated studies are fascinating as works of classification and cataloguing (Bowker & Star 2000). Authors of these studies argue that these are objective descriptions, and that they are critical for young researchers to understand important concepts and publishing trends in the field so that they can make their mark (Tsai & Wen 2005).

One way of understanding this is that these types of algorithmic reviews work within a realist ontology. Algorithmic reviews make assumptions about the object of the research, the research process and subjectivity of the researcher. Yet intuitively, the idea of mapping the field of TEL, of identifying common themes and topics, and specifying the internal structure of knowledge is not so different from the judgement reviews. In both approaches, materials (like the software tools, visualisation system, search engines), and categories (like learning, collaboration, formal/informal) are treated as innocent vehicles of discovery.

A discourse history of TEL research is about interrogating these assumptions. There is a gap here, and I believe it would be useful to understand the discursive work involved in what counts as TEL research. By starting from the premise that discursive work is invariably tied to socio-material relations, this opens up the possibility of research that traces the discourse history of how TEL has come to be what it is.

TEL as communities

A number of reviews of TEL as a field of inquiry are about different self-differentiated communities – how they are different and similar, and how they relate to each other. Czerniewicz (2008) classifies these communities using a Bernstein architecture of vertical and horizontal knowledge structures. For Czerniewicz (ibid.), vertical knowledge structures are hierarchical like a triangle. Underlying uniformities in knowledge at the base are classified up the hierarchy to create general propositions and theories. Natural sciences, for example, are routinely regarded in this way.

Horizontal structures are segmented into co-existing clusters, each with different assumptions about what counts as research and different criteria for framing what are regarded as legitimate questions and research approaches. Development in horizontal fields comes from new connections rather than integration with existing bodies of knowledge (Bernstein 2000). Using this framework, Czerniewicz (2008), notes that among TEL communities there is one clearly self-differentiated vertical community and a growing number of horizontal clusters. Both types are reviewed next.

The vertical community is the powerful American Instructional Systems Design (ISD) group, which centres around the Association of Educational Communication and Technology (AECT) and has a history dating back to 1929. ISD has been associated with learning and new technologies since the days of film strips. It became established in the 1950s when the US military began intensive use of technology in training (Saettler 1968). The extent of AECT activity is evident in instructional systems programmes and departments in the US (Indiana State University 2011; Penn State University 2015) and in the number of emeritus senior academics who are active in documenting the ISD knowledge base and history (Reigeluth & Carr-Chellman 2009; Merrill et al. 2008; Reiser 2001; Spector et al. 2012). This output can be described as retrospective synthesis. What is less obvious is where new ISD research is located and who is doing it.

Speaking for the ISD community, Merrill et al. (1996) are uncompromising in stating:

> Instructional science is concerned with the discovery of the natural principles involved in instructional strategies; and instructional design is the use of these scientific principles to invent instructional design procedures and tools. (p. 525).

Czerniewicz (2010) notes that the intention of this community is to proclaim one knowledge base to safeguarding the boundaries of their profession and maintain their standards of competencies (see also Ely 2000). In the process some ISD publications

claim absolute knowledge, with book titles like *Prescriptive Principles for Instructional Design* (Merrill et al. 2008); and absolute boundaries with claims like: "We don't want to cast anybody out of the discipline of instructional science or the technology of instructional design; however, those who decry scientific method, and who deride instructional strategies, don't need to be cast off; they have exited on their own" (Merrill et al. 1996, p. 6).

On closer examination of ISD texts, what emerges is that researchers in the field don't research new technology design or study education and learning. Delmont and Atkinson's (1995) metaphor of primary and secondary sites of knowledge production is useful here. Primary sites are constituted by the processes of production where things, ideas and materials are assembled, modified and transformed. Secondary sites are concerned with reproduction and defence. ISD uses the term educational technology to stand for what Januszewski (2001) describes as a "World view" of education which sees education as instruction. He goes on to describe instruction as prescriptions to bring about pre-defined and measurable learning outcomes. Like Merrill, Januszewski (2001) follows the ISD line: "As a world view of education, educational technology emphasises applying scientific techniques in solving educational problems in efficient and effective ways. This emphasis results in an attitude of action … This attitude values technique over philosophy" (p. 118).

The ISD community draws on general systems theory to construct 'technology', 'enhancement' and 'learning' as systems with feedback, goals, input, process, product and output (Salisbury 1990). In practice, ISD strategies and techniques dominate the design of computer-based training and curriculum structuring in the US. However, in its aspirations to scientism ISD exclude practitioner research, education studies, social science, computer science and learning science. It seems that those who argue that the field is a science are pitted against those who argue that the field shares many of the same identity struggles as the applied social sciences (Luppicini 2005). The latter take the view that the field of TEL is a loosely associated groups of social science researchers (Whitworth 2005). As a practitioner community, ISD is preoccupied with definitions and boundaries, systems, political

advocacy, and maintaining a professional powerbase (Nespor 2012). These dissonances make it difficult to locate 'research' in ISD. Perhaps Kirby et al. (2005) are right in observing that IDS has a proverbial axe to grind:

> The learning scientist is often trained in research and development institutions or laboratories and is encultured into the fund-writing and research community … Meanwhile, the instructional technologist continues to struggle with the colleagues requesting assistance with using PowerPoint for their biology lectures. (p. 46).

Returning to Czerniewicz's (2008) analysis of horizontal communities in the field of TEL, this is not overly concerned with representations of the field as cohesive or coherent, but rather suggests that a number of clusters co-exist. Taking only the groups with established journals, conferences, key texts, research groups and champions, the following four clusters can be described as self-identifying communities:

- Association for Learning Technology (ALT), an acknowledged profession community and field of research (Seale & Rius-Riu 2001)
- Learning Sciences (LS) (Sawyer 2005; Stahl et al. 2006; Dillenbourg et al. 2008)
- Computer Supported Collaborative Learning (CSCL) (Hoppe et al. 2007)
- Networked Learning (LS) (Goodyear et al. 2004; de Laat 2006)

These are separate and overlapping communities. The UK-based ALT publishes a journal called *Research in Learning Technology*, which attracts publications from the other clusters in addition to TEL practitioners and education researchers. The *Cambridge Handbook of Learning Sciences* describes LS as an interdisciplinary field that studies teaching and learning, and draws on the science of learning, including cognitive science, educational psychology, computer science, anthropology, sociology, neuroscience, and other fields. This authoritative publication aims to show how educators can use the learning sciences to design more effective formal and informal learning environments. (Sawyer 2005, p. 1). CSCL is a branch of LS based

in the US that has associations with cognitive science and computer science research (Boden 2006). CSCL and has been described as a branch of instructional technology (Koschmann 1996). In contrast, Networked Learning is UK and Europe based with a strong Australian connection. Its learning theories are socio-constructivist and collaborationist, and tend towards qualitative or mixed methods research (Dirckinck-Holmfeld et al. 2009; Jones et al. 2010). While these are the main clusters, there is a smaller group that draws on postmodernist approaches. Czerniewicz's (2010) summary is useful here: "These views argue for pluralism, criticism rather than evaluation, constant rethinking of beliefs and technology, a focus on power relationships as well as highlighting the relationship between corporate interests and technologies in the classroom." (p. 528). Interestingly, while there is a whole chapter on postmodern and post-structural theory in the first edition of the cross disciplinary *Handbook of Research for Educational Communications and Technology* (Yeaman et al. 2001), this does not appear in subsequent editions. I will return to this later in this chapter when reviewing the literature on theoretical resources.

Each of the four main clusters inducts new researchers into the history of its publications, conferences, projects and research teams; and each is about 'technology', 'learning' and 'enhancement'. Yet as noted by Jones (2004b), the researchers in these clusters are disciplined by feeder disciplines ranging from humanities to social sciences, information science to linguistics, and from computer science to education. Nevertheless, there is enough evidence to argue that self-differentiated communities clearly have a narrative on what TEL is and where it comes from, and researchers who are part of the community know themselves as TEL researchers. This observation is substantiated by two cross over forums that is the *International Journal of Technology enhanced Learning,* and *The Journal of Research & Practice in Technology Enhanced Learning.* Interestingly these journals attract researchers and readers mainly located in computer science faculties and extend to countries in the Asia-Pacific region (Bamasag 2015; Chan 2006; Rogers 2008; Valsamidis 2015). It is also evident that these communities are recognised by outsiders and each other as TEL reserachers. The question then is where did the clusters come from, and what keeps them separate but also connected?

There is a gap in the research that could draw on socio-material theory or discourse analysis to examine the discursive work that goes into self-differentiation and association between the clusters of TEL research activity. Nicolls (2008) has shown that using Foucauldian discourse analysis can be immensely productive in examining: "the influence of e-learning on the disciplines and disciplinary practices within universities." (p.164). There is scope to extend this kind of analysis to TEL research and to the history of how it has come to be what it is.

TEL as a profession

For some time now TEL has been documented as a professional field. In the UK professional pathways for development of learning technologist were mapped out in in 2001 (Beetham et al. 2001; Oliver et al. 2004). In the US, the third edition of the text book *Instructional Design Competencies: The Standards* (Richey et al. 2001) specified professional standards which have continued to be updated (Richey et al. 2011). Professional knowledge, scholarship and research are assimilated into TEL as a field of inquiry partly because researchers and professionals in the field are often the same people. This however also complicates professional identities when research, pedagogy, and technical roles are fluid.

TEL professionals are often regarded as services providers in universities, schools and training organisations. In higher education this can mean non-academic conditions of employment, ambiguity surrounding what counts as 'doing research' and 'new knowledge', practitioners with no formal research training, and researchers who don't have a teaching and learning role. In spite of these ambiguities, and messiness in practice, professionalisation of TEL is a powerful indicator that knowledge in the field is being formalised, codified, certified and regulated (Czerniewicz 2008; Macdonald 1995).

In this landscape of entangled knowledge practices, the question *What is TEL research?* prompts a range of responses. Jones (2004a) has observed that although some may argue that technologists draw upon knowledge production done elsewhere,

it is not so simple to say that researchers produce new knowledge and practitioners apply this. Practitioners in some of the feeder strands in learning technology do empirical research *and* develop theoretical accounts *and* write reports intended to inform practice: "It is not yet clear if this blurring of boundaries between technical work and knowledge production is simply a feature of an emergent profession or a more permanent feature of learning technology" (p. 2). Czerniewicz (2011) writes: "The field is so new and so rapidly forming as technology shifts, the gap existing between professionals and scholars may not be so wide as in other fields such as teacher education … [and] it is quite possible that new knowledge may be emerging from the professional field in ways that need to be tested by scholarly research, rather than the other way round" (p. 173).

These demarcations, and relationship struggles, between TEL as a profession and TEL as research are about what can count as TEL knowledge. In this struggle professional associations are powerful institutions. For example, the Association of Learning Technology in the UK has as its strap line "Improving practice, promoting research, and influencing policy" (ALT 2015). The idea that the purpose of research is to improve practice, and influence policy, is almost ubiquitous amongst TEL professionals. Some commentators are forceful in asserting that after 50 years of e-learning research there is no evidence of a knowledge base to inform practice (Alexander et al. 2006). As well, a recurring critique of TEL research is that design theory has become reified without any grounding in practice (Bichelmeyer 2004).

It seems almost shocking to question the dichotomy between research and practice, or science and applied science. The normality of what TEL researchers and professionals count as 'desirable' and 'good' are discursive effects which are under-researched. There is a precedent in that education researchers do examine discourse, the policy and practice language of competencies, standards, sanctions, and self-regulation (Edwards et al. 2004). This is an indication that there is value to be gained by tracing the discourse history of TEL research and working with conceptual resources that can characterise the productivity and limits of what is taken for granted.

TEL in policy narrative

In Chapter 1, I positioned the TEL call for funding documents (2006, 2007) as a vantage point for this study. These documents were a culmination of a gathering of funds, organisations, institutions, technologies and people. In the UK, the mainstreaming of TEL as a field of inquiry started with a change of government in 1997. On 8th July 2003 Charles Clark, the UK Secretary of State for Education and Skills (DfES), launched a Consultation Document, *Towards a Unified e-Learning Strategy* (DfES 2003). The launch was an agenda item at an ALT policy meeting (Hammond 2003), at which Diana Laurillard, Head of the DfES e-Learning Strategy Unit, presented the Consultation Document and the strategies that it covered. It is significant that in 2003 the UK had such a e-Learning Strategy Unit with a Head who was a TEL academic (Laurillard 2002), and that this academic was presenting a policy document at which the Minster of Education was present.

The event was reported in the July 2003 ALT newsletter with the title story "ALT: How did it all start?" (Hammond 2003). This article is about the alliances and pressures, that led to the launch of the Association in April 1993; one of these pressures being the "growing number of academics in HE who were becoming involved in activity under a burgeoning diversity of three-letter acronyms – CAL, CBL, CML, CBT, CMC and the like – all referring in one way or another to learning supported by technology" (p. 1). Reported in the same newsletter is the banner "10th anniversary conference marks e-learning 'coming of age'" (p. 2).

In the period between 2003 and the TEL call for funding in 2006 and 2007, TEL research as a field of inquiry and its history were presented at seminars, conferences, and policy events as a grand coming-of-age narrative, but with still a lot to do. This is captured in Laurillard's (2008) inaugural professorial lecture at the Institute of Education in London:

Education is on the brink of being transformed through learning technologies; however, it's been on that brink for some decades now. The argument I want to

advance in this lecture is that never before has there been such a clear link between the needs and requirements of education, and the capability of technology to meet them. It's time we moved education beyond the brink of being transformed, to achieve its true potential. (p. 1)

Old media and delivery technologies against the new

0	Writing	Interactive computers	1970s
1400s	Paper	Local drives & discs	
1400s	Printing	WIMP interfaces	1980s
1500s	Published books	Internet	
1600s	Indexes, paragraphs	Multimedia	
1700s	Pamphlets	Worldwide Web	1990s
1800s	Photos, sound, film	Laptops	
1800s	Postal services	Email	
1900s	Libraries	Search engines	
1900s	Bibliographies	Broadband	
1940s	Television, phones	3G mobiles	2000s
1950s	Paperbacks	Blogs	
			30 years

Laurillard, 2007, slide 19. This is an example of a policy narrative that presents a linear history of technology progress

Figure 2.2   TEL history as technology innovations.

A policy narrative about research announces and politically justifies a particular change agenda. This is evident in a number of publications from 2004 onwards that are described as grand challenges for science and society (Hoare & Milner 2004; Laurillard 2007, 2008; McGettrick et al. 2005; Taylor et al. 2004). The policy narrative that announces *what TEL is and where it comes from* works visually and verbally by simplifying the history of technology innovation. (Figure 2.2). The audience is told that old technologies of writing, the printing press, public libraries, bibliographies, and so forth, have taken many centuries to develop. In contrast digital technology innovation has been very rapid. This argument is then extended to the history of pedagogy and education to assert that what it takes to learn does not change and active learning is a common thread in theories of learning. (Laurillard 2008). The final part of the policy narrative asserts that *TEL as a field of inquiry*

needs to reinvent itself to deliver: 'personalisation', 'flexibility', 'inclusion' and 'productivity' TEL call for funding documents (2006, 2007).

In Foucauldian discourse analysis, this rationalised history smooths over the messy enactments that are specific to time and place; it works to create a particular regime of truth. This not a criticism as such; this is one of many useful accounts of the field that orientate TEL researchers to the important themes and the types of research that are likely to be funded. The gap is in the absence of questions about where these themes and these constructions of 'technology', 'learning', 'enhancement' and 'research' came from. My argument is that the same questions can be usefully examined by drawing on conceptual resources that allow specificity.

TEL as forms of knowledge

This part of the literature review is about the kinds of knowledge that is published as TEL research. Published TEL research is informed by many different forms of theorising. Some of these are represented in the publications like the *Handbook of Research on Educational Communications and Technology,* now in its 4th edition (Spector et al. 2014), and collated in some of the volumes in the *Open and Flexible Learning Series* (e.g. Conole & Oliver 2007). Others are evident in education research (Carmichael, 2011; Edwards et al. 2004; Fenwick et al. 2011; Fenwick & Edwards 2010; Fejes & Nicoll 2008; Field et al. 2009); in the related field of interaction design (Kaptelinin & Nardi 2006; Rogers 2008); in TEL literature that self identifies a commitment to postmodernism (Anderson 1992; Yeaman et al. 2001); and in a new wave of TEL literature with a recognisable intellectual commitment to uncertainty (Bayne 2015; Haxell 2008; Thompson 2015; Knox 2013).

While acknowledging this complex diversity, and without claiming a wholly 'hard cut' between deterministic and non-deterministic inquiry, for the purpose of this review, I explore the differences between two kinds of TEL knowledge. The first broadly, comes from the process of knowledge production that is concerned with

building on received knowledge and prior research. This characterises the mainstream of TEL research which has a commitment to 'discovering essential truths'. The second process of knowledge production is, broadly a productive critique, and forms of analysis characterised by unsettling the engineering order of things and engaging with uncertainty through various forms of deconstruction and relational socio-material analysis. Both of these are discussed next.

The first kind of TEL knowledge interprets the achievements and gaps in TEL research in relation to established systems of knowledge categorisation. This form of TEL knowledge builds on frameworks that assert separate categories of knowledge, in order to then argue that TEL research is about relations between these categories. Over time these categories are taken as *real*, even *objective* representations of the world. For example Hargreaves (1996) differentiates between scholarly knowledge that is generalised, codified, rational and explicit; and professional knowledge that is context specific, oral, practical and tacit. Taking these categories literally, a number of TEL researchers extrapolate that the relation between these categories (scholarly vs. professional knowledge) is an important area of TEL research (Conole & Oliver 2007; Czerniewicz 2008).

Another categorisation system references Kuhn's (1970) seminal text on paradigms and science. Paradigms are categories of progress along a continuum. So, for example, TEL is described as a mature applied field and any controversies that contest this are excluded (Reiser et al. 2006). Or it is described as a new discipline that is making progress in the right direction (Conole 2004). Or it is not quite there and so is in an unfinished state, classified as multi-paradigm or pre-paradigm (Dawson & Ferdig 2006).

A powerful categorisation system segregates knowledge domains into disciplines and field (Luppicini 2005; White & Liccardi 2006). Strathern (2004) has added other categories by describing new forms of connections:

- multi-disciplinary – as an alignment of resources and skills from different disciplines;

- inter-disciplinary – where there is a common shared framework across disciplines in which each makes a contribution; and

- trans-disciplinary – as a kind of super inter-disciplinarity where "the focus is on its context of application, and on a particular approach to problem-solving that creates its own theoretical impetus" (p. 70).

I bring this in here, because the UK TEL Programme critiqued TEL research because it was deemed as segregated across knowledge domains. A commitment to interdisciplinary is evident in that the TEL Programme was funded by both the Engineering and Physical Science Research Council (EPSRC) and the Economic and Social Research Council (ESRC). However this shift was not ontologically radical. It was a call to revise boundaries and to forge new relations across knowledge domains (TEL call for funding documents 2006, 2007). This kind of argument is typical of the mainstream of TEL research where categories and relations were taken as neutral albeit in need of rational revision. A different starting point is to assume that categories and relations, are never neutral, as they are invariably active in shaping what counts as TEL knowledge. There is a gap here and I propose to examine the socio-material relations between categories of knowledge by drawing on the conceptual resources introduced in Chapter 1.

Moving on to the second kind of TEL knowledge, in this I include the TEL literature that grapple with the uncertain and indeterminate and is critical of the realist rational traditions evident in the mainstream of TEL research. In this grouping there are differences between the TEL literature that has a declared affiliation to the postmodern and the poststructural (cf. Yeaman et al. 2001; Voithofer & Foley 2002; Hlynka 2003); and the literature in which relational and ecological impulses predominate ((Bayne 2015; Haxell 2008; Thompson 2015; Knox 2013). For the sake of brevity I call these strands: 'postmodern TEL' and 'relational TEL'. I suggest that these strands draw on different theoretical resources so that analysis and critique, and

therefore new understanding, is put to work in somewhat different ways. Both strands of TEL literature are reviewed next.

Taking 'postmodern TEL' first, Postmodern writers in the field of TEL are incredulous about the certainty of truth claims about educational technology. Postmodern in these TEL text and many others, but not all[13], is in opposition to modernity. Modernity is characterised by rationality and the *categories* described earlier are examples of rationalisations. In research practices, modernity is enacted in the search for essential truths about the world. It is assumed that these truths can be discovered, and harnessed for the greater good. Postmodernity in contrast is uncertain about these precepts. Postmodernity is a condition in which it is difficult to know the world in absolute terms. This means that metanarratives, generalities, and universal truth are open to examination (Lyotard 1984), as are the relations between constructions of the 'real' and the 'imaginary', what Baudrillard (1991) calls the simulacrum.

Decentring rationality changes the kinds of TEL knowledge that is produced. For example in some publications TEL research is reinvented as a form of literary criticism where the role of the researcher is similar to a : "film critic, art critic, or television critic: to inform a target audience as to the introduction of a new text, to provide a critical commentary, to disclose to its audience how the text does what it does" (Yeaman et al. 2001, p.2). In other research TEL knowledge is positioned as a form of continuous debunking where "Inquiries concerning truth, meaning, consciousness, and notions of 'self' are basic to our field." (Mufaletto 2001, p. 4).

Broadly TEL knowledge as 'opposition' is illustrated by feminist political activism that set out to: "challenges dominant masculinist views of knowledge by using strategies of opposition, resistance, and deconstruction" (Anderson & Damarin 2001, p.3) TEL research from this lineage asks how technologies construct the subject (Anderson 1992); examines the bodies politic and the ways women's bodies are

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[13] There are excepts in contemporary interpretations of Foucault's later works. For example Seppä (2003) show that Foucault's aesthetic theory tackles the utopian task in much the same way as both Kant's and Baudelaire's critical modernity.

positioned by discourses of gaze, and spectacle, (Haraway 1991); and questions how concepts that govern TEL design (for example, personalisation and learning style) are associated with the sex/gender and other binary categories (Bryson & deCastell 1994).

This literature is included in this review because examples of decentralising rationality and deconstruction illustrate a gear change from the literal to the metaphorical, from the absolute to the interpreted, where form and function are inseparable. This is illustrated in the following example of deconstruction. Hlynka (in Yeaman et al. 2001) points out that one of the key concepts of post-structural methods is *deconstruction*, which is associated with Derrida (1998) (see also Peters & Biesta 2009). He demonstrates this with the example of what it means to *design*. 'Design', 'analytical design', 'representations of design', 'task analysis for design' are favoured categories in modernist writings about TEL. However deconstruction analysis shows that *to design* is to constrain and limit. Some of the most powerful examples of digital designs initially resist the constraints of prior design; they are instead more like experiments. The valorisation of design, deconstructs under examination, and the need to include some opportunity for play and non-design comes into focus. In fact, it becomes evident that non-design is mostly already present in good design, in spite of claims about the design process. The deconstruction of meaning produces critique, interpretation, criticism, and the multiplicity of literary invention. The productivity of these techniques opens up methodological possibilities, and this is taken up in the next chapter. However, while this form of critical TEL work was visible in TEL research in the 1990s, after around 2003 it seems to have been assimilated into the TEL literature as part of the constructivist paradigms (Fardanesh 2006).

Earlier I described postmodern analysis as deconstructive. In writing this thesis I don't share an intellectual commitment to radical relativism sometimes associated with recursive deconstruction. The distinction between the intellectual and the pragmatic may seem academic but there is practical merit in heeding some salutary self-parody and stopping in time:

And you grant yourselves the privilege of continuing to regard as unresolved, that is as well formulated, questions that technical science believes it answered but in truth only adequately brought to the fore. For you solutions are just illusions, failures to maintain the integrity due being – or some such thing. I hope you have patience. You'll hold out forever with your incredulity. But don't be surprised if all the same, through your irresolution, you end up wearing out your audience. (Lyotard et al. 1988, p74)

Instead of recursive deconstruction, I have a pragmatic commitment to examining uncertainty.

Turning to 'relational TEL', this new wave of TEL research has antecedence in the critical analysis of 'technology' and 'learning' in education studies (cf. Biesta 1998; Chappell et al. 2003; Edwards et al. 2004; Fejes & Nicoll 2008; Nespor 1994; Solomon et al. 2007). Since 2005 a new wave of TEL researchers have taken up the challenges of TEL research that embraces uncertainty and undecidability (Derrida 1996). Much of this work centres around scholarship in digital education for example at the Centre for Research in Digital education, University of Edinburgh; and in publications like the journal of Learning Media and Technology which was previously the Journal of Education Media (1996-2004), and before that the Journal of Education Television (1975 -1995). In research practices, 'relational TEL' draws on sensibilities from critical posthumanism (Braidotti 2013) and science and technology studies (Sismondo 2010).

Relational sensibilities changes the kinds of TEL knowledge that is produced. Sørensen for example, argues that "materials may be used by humans, but they may also use humans and influence and change the educational practice, which then is no longer particularly human; instead it is socio-material." (p. 2, italics in the original). In her account posthumanism is a methodological mode which is about following the action and imagining practices in which configurations of humans and things might be different. Fenwick, Edwards, and Sawchuck (2011) explore the human-centred or 'anthropocentric' ways of thinking that privilege the intentional human subject so

that the human is assumed to have greater agency and worth than the non-human. The question then is how to follow the action without these prior judgements. Importantly, this is not another version of objectivity or neutrality because part of the non-human are the resources, theory and methods, that are mobilised by the researcher. An interesting example of this is evident in Bayne's (2015) article on What's the matter with 'technology-enhanced learning? Bayne draws on three different frameworks: science and technology studies to deconstruct the 'technology'; critical post-humanism to analyse 'enhancement'; and work on the language of learning (Biesta 2005) to problematise the 'learnification' of education. This is interesting because there is no pretence that these resources are "homogenous, or that they would converge on a single position with regards to TEL or its broader context" (Bayne 2015, p.8). Rather the aim is to open new research spaces:

> As researchers and practitioners of digital education , we need to move away from our over-emphasis on how technology acts on education, or how education can best act on technology. Let us rather acknowledge that the two are co-continuative of each other, entangled in cultural, material, political and economic assemblages of great complexity. (Bayne p.18)

The work in this thesis a response to this recognition of a gap in TEL research.

Broadly TEL knowledge as relational socio-material analysis seeks to critique and disrupt, trouble and unsettle, in order to open new areas of debate and to reimage and re-envision. This invariably involves crossing knowledge boundaries. Some research in this mould works by taking hot topics of the day and systematically tracing the relational construction of it as 'real'. For example Knox (2014) has studied massive open online courses (MOOCs) and demonstrated an irreducible diversity of participants. In doing so he challenges the generalised notion of a 'student'. In another study Knox (2013) examines the literature on Open Educational Resources (OER) and shows that this edifice of reality relies on under-theorised and literal interpretation of the term 'open'. Edwards and Fenwick (2015) turn their attention to digital analytics and observe that, "In principle, the fallible professional is displaced

by the infallible technology. In practice, it is obviously more complex than that." (p. 2). By examining linkages of big data and software codes alongside professional work and learning, they are deploying relational socio-material analysis as a way of insisting on extending the debate beyond the niche community of analysts. Relational analysis has opened taken-for-granted and compartmentalised bodies of knowledge elsewhere for example in the effects of algorithms, codes and standards in curriculum design and enactment (Edwards and Carmichael 2012; Edwards 2015). These studies examine 'what is' and this is similar to my question *What is TEL research?* The addition of *Where does TEL come from?* extends the timeframe and addresses the gap which I call the discourse history of TEL research.

As well as troubling the taken-for-granted, TEL knowledge as relational socio-material analysis is methodologically experimental. For example Hauxell (2008) describes the "particular and peculiar effects of text messaging for counselling.." (p.1) by tracing fragments of data as relations between things and people. Thompson's (2015) describes the work and everyday learning practices of self-employed contingent workers in Rwanda, Kenya and Canada and draws attention to "Learning ecologies" (p. 14) and the "growing sophistication of digital fluencies" (p. 1, italics in the original). These studies suggest that 'relational TEL' has an affinity to following the action and depicting this in rich descriptions. Moreover talking about text and other data as performative emphasises what is does and what the researcher is doing. Sørensen, for example, is quite explicit "a methodology for accounting for materiality of learning is developed in this book by actually doing this: accounting for the materiality of learning." (p.19). I understand this as a pragmatic commitment to examining uncertainty.

 Asking the questions *What is TEL? and Where does it come from?* suggests a history of construction of things being made and becoming 'real'. It predicates an uncertainty of coming into being, and the methods that perform this. How to trace the construction of reality is taken up as a methodological question in Chapter 3.

Locating a vantage point

In writing the section on TEL as a field of inquiry it was noticeable that accounts of *'what TEL is, and where it came from'* depended on the specificity of particular gatherings of technologies, people and ideas. Historical and geographical locations and what is mobilised and associated with TEL in a particular time and place seem to matter. In contrast, in many accounts of TEL research, past diversity, contradictions and conflicts are smoothed over. They are in the background, and not the focus of the work. TEL history is narrated to fit some particular purpose, and allocation of space (and word count) in a report, journal article, presentation and so forth. Simplifications are an inevitable part of writing any history; however, simplifications are not all the same. Simplifications do different kinds of work, and I am seeking to disrupt accounts of TEL research which separate where TEL research comes from, and what TEL research is, that is, the process from thing itself. This is because the separation enacts an ontology "where reality is assumed … to be a pretty determinate set of discoverable entities and processes. That such is what the world *is*: a set of possibly discoverable processes" (Law 2004, p. 9). But what kind of knowledge of TEL history is produced by these separations and how can it be different? I return to this question in the review of conceptual resources in the next section. I raise this here because to complete the review of TEL-specific literature I need to perform a tactical simplification. This manoeuvre involves pausing history and calling it the starting point. To do this I review the literature relating to this beginning, which is about EU funding regimes, political calls for unification, and research that can inform practice.

There are of course many messy partial beginnings in doing research, but in writing this thesis, the recurring beginning is a particular text that I introduced in Chapter 1. For a time in the UK, research into technology *and* learning converged around the nationally funded Technology Enhanced Learning Research Programme (2007–2012) and the TEL call for funding documents (2006, 2007) that invited researchers to bid for TEL project funding. The funding of the UK TEL Research Programme as an addition to the Teaching and Learning Research Programme (TLRP) (1999–2009)

was an important juncture in absorbing TEL research into the long-standing controversy surrounding the relationship between research policy and practice in education; and the intellectual debates about science, technology and society (cf. Strathern 2004).

In contrast to the historical terms used to describe the field (e.g. e-learning, and computers in education) and the terms used by self-differentiating groups and professional associations, the phrase Technology Enhanced Learning came from the European Union (EU)–funded information agency CORDIS (Community Research and Development Information Service), which is responsible for reporting on EU-supported research. In policy terms, the shift in terminology from e-learning to TEL was a funded public relations rebranding exercise. The rebranding was evident in the EU-funded Framework VII research stream called Technology-enhanced Learning (TeLearn) (2006), where the brief was to explore what is described as 'innovative technologies' and 'leading-edge technologies' for 'competence development throughout life'. The TeLearn stream emphasised technology and competencies and was positioned as a 'new' research area. The rebranding was in response to the European Commission's Open Consultation Process called *New Research Challenges for Technology Supported Learning*, which led to a report with the same title (European Commission 2001). Basically the political message was spelled out that if researchers hoped to secure EU funding they had to demonstrate measures to unify their fragmented research communities and to develop more instrumental research goals. Successive programmes funded by the EU took up this mantle. For example, the PROLEAN Network of Excellence was concerned with technology-enhanced professional learning (2004–2008); the Kaleidoscope Network focused on TEL and access to cultural heritage (2004–2008); while the STELLAR European Network of Excellence was tasked with unifying the diverse TEL communities (2009–2012) (Sutherland et al. 2012).

The phrase Technology Enhanced Learning was taken up by the TEL Research Programme (2006–2012). It was first used in the UK and the TEL Programme call for funding document (2006) entitled *Understanding, creating , and exploiting*

digital. Research on Technology Enhanced Learning. The reason for this was explained in a footnote:

> This Call [for funding] uses the phrase 'technology enhanced learning' to refer to what has recently been termed 'e-learning'. The European Commission is currently using the phrase 'Technology Enhanced Learning' for Framework VII, and will promote it as a 'new' research area. This Call uses the same phrase in order to support that vision, and to ensure alignment with European research groups working in the same field. (p. 1)

In the UK, TEL research was positioned as a follow up to the Teaching and Learning Research Programme (1999–2009), the UK's largest ever educational research programme, spanning 10 years and coordinating 7,000 researchers and more than 100 research projects. The projects mark an important juncture in the field of TEL for the following three reasons:

First, the TEL programme assumed that digital technology has ubiquitous presence in all aspects of life in the developed world, and that learning involves technology in some way (c.f. DfES 2003). The document located TEL research within a more or less established science paradigm (Kuhn & Hacking 2012); and invited TEL researchers to frame research drawing on technological, social and cognitive sciences.

Second, the TEL programme emphasised the delivery of results, in terms of measurable outcomes and impact (James & Brown 2005). The TEL Call, part of the TLRP, was a response to the climate of critique of education research in 2005. This is exemplified in Geoff Whitty's (2006) inaugural lecture as British Education Research Association President 2005. He summarised the criticism of education research in the UK in strong terms, using phrases such as: lack of rigour and knowledge accumulation, theoretical incoherence, ideological bias, irrelevance, lack of user engagement, poor dissemination, inaccessibility, and low value for money.

Parallel attacks on education research are documented in Europe, the US, Australia and around the world (Whitty 2006).

Third, the TEL programme stipulated the need to demonstrate interdisciplinarity, accountability and user engagement as conditions of the funding. In addition, researchers bidding for funding were asked to address one of four broad themes which were referred to as 'personalisation', 'flexibility', 'inclusion' and 'productivity'. On the one hand, this was opening up the field to encourage scholars to engage with contemporary debates on modes of knowledge production (Gibbons 1994; Klein 2008; Nowotny et al., 2001; Field et al. 2009). On the other hand, it was steering the field towards particular kinds of applied research.

The TEL call for funding documents (2006, 2007) embody the messy enactments that are specific to the time and place of the text. Foucauldian discourse analysis is sometimes described as the "history of the present " (Rabinow & Rose 2003, p19). By locating a starting point in these documents it becomes possible to ask specifically, *What is TEL research* (at the vantage point)? and *Where does this come from?* Since the Call led to a series of funded projects I follow discourse history into its future up to 2012, and the final event of UK TEL Programme .

In 2006 and in 2007, TEL researchers seeking funding paid attention to the TEL Programme themes of 'interdisciplinarity', 'user engagement', 'personalization', 'flexibility', 'inclusion' and 'productivity' (see Figure 2.2). They (and I include myself in this) were inducted and then orientated themselves to the types of research that was likely to be funded. I am not suggesting that it could, or should have been different. The gap is in the absence of a socio-material history of where these themes came from, and how the themes opened some, and closed other, ways of understanding 'technology', 'learning', 'enhancement' and 'research'.

Configuring the gaps

In Chapter 1, I used a form of literature review to introduce the field of TEL, but expanded the scope of what counts as TEL research. Because of this, the background history of TEL research includes literatures from computer science, cognitive science, STS and other fields. I also introduced conceptual resources to inform this thesis. This entailed reviewing Foucault's writings and the literature from actor-network theory, especially the methods textbooks on non-deterministic empirical research by Latour (2005) and Law (2004).

The literature review in this chapter has focused mostly on publications that are about TEL as a field of inquiry, the conceptual orientations that theorise the scope of TEL as a field of inquiry, and the research questions this focus implies. In these various reviews, I have made assertions about gaps in the literature. At this point it perhaps prudent to recognise some possible misunderstandings that I might have created:

- First, choosing to examine the discourse history of TEL research may seem to edge towards a wholesale attack on contemporary practices of TEL research. This is not my intention. A non-deterministic ontology predicates that nothing is as it seems, and this is what is interesting. My concern with *uncertainty* is that it effects my research questions. Furthermore, in Chapter 1, I introduced a vocabulary for examining the productivity of uncertainty by empirically tracing the emergence of *discourse regularities* and how these work. From this chapter, the discussion of *construction*, as developed by actor network-theorists, adds to this vocabulary.
- Second, non-deterministic inquiry, that draws on Foucault and actor-network theory, positions reality as generative and constructive. In other words, work is involved in making things real, including 'facts', 'technologies', 'learning' and 'enhancement'. This is not the same as an intellectual commitment to postmodernism or post-structuralism (which might leave the audience behind). Nor is it the same as philosophical idealism (where materiality has no place), or

social constructivism (where effects of the 'natural and material' have no place), or realism (in which the world is objectively knowable with the use of proper method).

- Third, I acknowledge that a discourse history of TEL research does not prioritise applied and practice-based approaches or research that has obvious utility for policy makers. I argue that writing such a history is not a disengagement but rather an experiment in how to engage with a world in which "the will to purity – and the conditions of possibility for purity are in decline." (Law 2013 , p.1).

But if there is already a literature on TEL as a field of inquiry, how will a discourse history of TEL research be any different from this literature?

Although much of the review has been about what is TEL as a field of inquiry, earlier in this chapter, I described how TEL history is described in terms like 'mature', 'new', and 'making progress'. This comes from a particular reading of Kuhn's (1970) analysis as depicting an objective reality about the state of a discipline. Critically, such a history of TEL simplifies the main features of Kuhn's account of science history in *The Structure of Scientific Revolutions*. For Kuhn, scientists don't come to their work naïvely, they come with a whole personal and cultural history that he calls a paradigm. In Kuhn's analysis, scientists solve empirical and theoretical puzzles by working within the paradigm and adapting and extending it. Kuhn's 'scientific revolution' is only possible when a sense of crisis is fortified by a critical mass of supporting alliances, so that the paradigm is changed radically. Kuhn's account has similarities with Latour and Woolgar's (1979) descriptions of Salk scientists who solve problems by drawing on a mixture of craft knowledge, instruments, theories and assumptions. The idea of a gathering or assembling of forces is powerful in that it is possible to explain change without the need to differentiate between things human and non-human, physical objects and ideas, and networks large or small. Law uses the term hinterland to refer to the way in which the 'person' is also an assemblage of materials, history and biography. Both Law (2004) and Latour (2005) describe the way in which the 'person' is also an assemblage of hinterlands which shape subjectivities. These insights disrupt the idea

that TEL as a field of inquiry is in various states of completeness, and the assumption that technologies are engineered with explicit know-how.

In these terms, the history of TEL as a field of inquiry is the discourse history of construction, where *construction* is the work involved in the making of realities. Although my questions – *What is TEL research?* and *Where does it come?* – are not new, there is a gap in that a non-deterministic configuration of conceptual resources has the potential to produce different ways of understanding TEL research. However, the literature review has shown that there is no obvious methodological road map to mobilise these new resources. This is part of the work of this thesis and it is taken up in the next chapter.

Chapter Three: Archives, discourse and methods

I would like to divest concern with method of its inheritance of hygiene. I want to move from the moralist idea that if only you do your methods properly you will lead a healthy research life … I want to subvert method by helping to remake methods: that are not moralist; … and that start to do this by escaping the postulates of singularity, and responding creatively to a world that is taken to be composed of an excess of generative forces and relations. (Law 2004, p. 9)

The Archive is made from selected and consciously chosen documentation from the past and also from the mad fragments that no one intended to preserve and just ended up there. (Steedman 2002, p. 68)

Introduction

This methodology chapter describes the process of tackling the research questions: *What is TEL research?* and *Where does it come from?* In practice this involved interpreting the abstract ideas and conceptual resources described in Chapter 1, to develop guidelines and processes for gathering data, analysing the data and then presenting the findings. The conceptual resources introduced the notion of non-deterministic inquiry, and the literature review confirmed the potential for producing new knowledge by shifting attention away from the search for 'essential truths' towards describing the 'discursive work' involved in making realities. 'Reality' like, for instance, the seemingly ubiquitous presence of digital technology in places of learning, and the contemporary association of learning and pedagogy with measurement of productivity, flexibility and personalisation in the TEL call for funding documents (2006, 2007). There are no off-the-shelf methods for such an inquiry, so part of the work of this chapter is to justify the technical construction of the inquiry, and show that it is fit for purpose and has the capacity to produce new knowledge.

Law (2004), quoted above, writing about social science research methods, captures the sense of hygiene and moralist undertones in some accounts of research methods in the TEL literature as was mentioned in Chapter 2. One of the effects of

objectifying research methods is to neutralise the performative work of research itself. Actor-network theorists advocate giving no a priori status to any entities, be they human, digital, semiotic or material (Callon 1986, Latour 2004); but they also recognise that this is impossible because researchers are "both in-here, as subjects, and out-there, as networks of meaningful and material relations" (Law 2004, p.68). The question then is how to recognise and represent messy, partial connections between things human and non-human in data gathering, analysis and writing; and to avoid some of the absurdities this could entail (McLean & Hassard, 2004). This is the task of this chapter.

This chapter is organised in six sections. They are:

- *Inquiry process in retrospect.* This begins with a discussion of qualitative TEL research and then summarises the data gathering, the analysis and presentation of findings. This is a retrospective account that acts as map of how the research process unfolded.

- *Inferring methods.* This section reviews methodology texts from Latour (2005), Foucault (2002), and Law (2004) in order to develop some guidance for both assembling the data and the analysis process. The scope of the research is described in terms of materialisation (production of technology); translations (in connection to education research); and forms of ordering (i.e. how coherence and non-coherence can be performative).

- *The question of archives.* This section reviews the literature on traditional and contemporary archives and archival studies, and describes the differences in data vocabulary across disciplines, fields and in software analysis tools.

- *Assembling the data.* This section describes in some detail the process of assembling data sources from archives on the internet and the internet itself (as a kind of archive). It describes the process of sampling and gathering materials. An important part of this process is making judgements about validity, relevance, and organisation of the archive.

- *Collections and analysis.* For the analysis, the qualitative data analysis tool NVivo 10 was used to organise the collections and examine the materials using various discourse analysis techniques.

- *Configuring the inquiry.* The final section combines the work from the previous sections to describe how the findings of Chapters 4, 5 and 6 are organised.

Inquiry process in retrospect

Qualitative research in TEL studies are often presented as investigations into some phenomena that are framed by the researcher before starting the investigation (Remeny 2008; Mayes & Freitas 2005; Andrews & Haythornthwaite 2007; Conole & Oliver 2007). Reasons for focusing on a particular field are explained in terms of the researcher's particular background and interests and the state of the literature in relation to the research questions (Seale et al. 2004; Potter & Hepburn 2007; Silverman 2006). This is what I have done so far, and in so doing I am invoking what Sorensen (2009) describes as "the researcher's rationality and his [sic] scientific embeddedness [which] are presented as the background for examining precisely this object and this field" (p. 32). Ethnographic studies have documented how the objects of research are constructed as part of the research process, for example, in science and technology studies (Cetina 2009, Latour & Woolgar 1986), and more recently in a TEL research project (Rimpilainen 2012). A key feature of these studies is that they are specific to location and projects.

The TEL research questions tackled in this thesis are not specific to a particular geographical location, project or case study. I am interested in how TEL research, as a field of inquiry, has come into existence, survived and changed over time. The scope of the inquiry is not self-evident, and initially even the period involved was unknown. Following Law (2004), it seems that "simple clear descriptions don't work if what they are trying to describe is not itself very coherent" (p. 2). In this space of relative disorder, the conceptual resources provided ways of enacting research in

relation to decisions about (1) data, (2) analysis, and (3) the form and structure of writing to describe what emerges from the inquiry. These are described next.

(1)   Data. Decisions are involved in what counts as data and where this comes from. In a relational socio-material ontology, if there are no material traces then nothing is going on and there is nothing to explain (Latour 2004). This means that discourse leaves traces in inscriptions that are materials, and material objects are gatherings of relations and discourses. Early in the research process I interpreted material traces as equivalent to material objects and inscriptions. Examples included are: documents and other texts, images, videos, hypertext, digital artefacts, computers and software, and multimedia. To study the discourse history of TEL research, the data for such an inquiry would be materials that are traces of TEL research over time.

I refer to this data as an archive. Initially I focused on formal archives of peer-reviewed publications and databases like ERIC (Education) and ACM (Technology Sciences). Contemporary work on archives that draws on the work of Foucault questions the conventional understanding of the archive as an organised depository of knowledge managed by gatekeeper archivists (Burton 2006; Schultz et al. 2008). This is important because it indicates the possibility of vested interests preserving some traces and not others. When I started collecting data in 2010, other forces were at work in preserving and eradicating material traces. The possibility of digitisation, internet access, and publishing on the web has changed what is preserved, lost and possible to find (Bishop 2008; Brugger 2005; Corti & Backhouse 2005; Geiger et al. 2010). This presented additional possibilities for gathering data. The data assembled to address the research questions in this thesis is sourced from both formal archives and less formal locations. What is an archive and how it is assembled is discussed later in this chapter.

(2)   Analysis. In socio-material research traditions, analysis is a form of enactment. The ontology that problematises the object of this investigation, namely *What is TEL research?* also problematises research methods. More specifically,

categories like research questions, instruments for data gathering, data analysis techniques and so on are also heterogeneous networks that include "researchers, objects, humans and other things, each contributing to forming the object and field through their mutual interactions" (Sorensen 2009, p. 33). Education research and technology design research that draws on Foucault (Fejes & Nicoll 2008; Fox 2000; Gerrie 2003), and actor-network theory (Mulcahy 2012; Hutchins 1995; Edwards 2012) often integrate a variety of methods suggested by feminist, narrative, case studies, ethnomethodology and archival studies (Fenwick & Edwards 2010; Steedman 2002). This eclecticism is a positive indication that each empirical investigation is treated as a different enactment. As Foucault (2002) writes: "Regularities … are not given once and for all; the same regularity is not to be found at work in Tournefort and Darwin, Lancelot and Saussure, Petty and Keynes" (p. 162). In the opening quote to this chapter, Law's injunction to divest methods of hygiene and singularity riles against anything calling itself an overall methodological framework and this is consistent with recent writings from actor-network theory (Law et al. 2011; Savage et al. 2010). Scholarship like this are examples of configuring methods that respond "creatively to a world that is taken to be composed of an excess of generative forces and relations" (Law 2004, p. 9). Building on these examples guidance on analysis techniques is drawn from a close reading of methods text from Latour (2005), Foucault (1991, 2002) and Law (2004). This is described later in this chapter.

(3)   The form and structure of writing to describe what emerges from the inquiry. Empirical accounts of what emerged from the inquiry is written as a discourse history. The conceptual resources did not immediately suggest a structure; this emerged from the detailed work of gathering data and doing analysis. To follow through the intuition of uncertainty described in Chapter 1, my focus initially was on the UK TEL call for funding documents (2006, 2007). Through a process of iterative analysis these documents emerged as a vantage point, a place to ask *What is TEL research?* Each of the empirical chapters (4, 5 and 6) features this vantage point.

To follow through on the discourse history of TEL research, I focused on close analysis of statements and their relations, and I used this to generate descriptions and examples of the discourse and how this worked to construct technology, enhancement and learning, and TEL research. From this, patterns began to emerge of discursive shifts in the history of TEL research. The final organisation of the empirical chapters emerged from this work and is described at the end of this chapter.

Inferring methods

In Chapter 1, I described TEL research as a history of interruptions going back to 1945 and introduced three trajectories of non-deterministic inquiry. In the first trajectory, each of the interruptions described a discourse and the regime of truth about TEL research. In the second, the discursive shifts in TEL research demonstrated that TEL research *has not always* been the same assemblage of technologies, theories of learning, funding streams, accountabilities and so forth. The third trajectory is about differences in enactments of categories like technology, learning, and enhancement. In other words, things that are taken to be the same can be enacted in different ways, raising questions about how this works in practice.

These three trajectories come from analytical work on the inquiry process. To write a discourse history of TEL research entailed inferring guidance from methodology texts that demonstrate non-deterministic inquiry. Specifically, I draw on texts from Latour (2005) on uncertainty and the construction of realities; Foucault (2002) on discourse and regularities; and Law (2004) on coherence and non-coherence that is, in other words, ontological multiplicity and performativity. The empirical chapters (4, 5 and 6) draw on guidance from each of these protagonists respectively. The emphasis in each chapter is a different response to what emerged from the data.

Latour on uncertainties and construction

In Reassembling the Social: An Introduction to Actor-Network-Theory, Latour (2005) describes a set of strategies for tracing the uncertain beginning of sociotechnical phenomena. An actor or actant in anything (human and nonhuman) that has effects. Latour writes:

> "In plain English to say something is constructed means that it's not a mystery that has popped out of nowhere, or that it has a more humble but also more visible and more interesting origin. Usually the great advantage of visiting construction sites is that they offer an ideal vantage point to witness the connections between humans and non-humans." (p. 88).

The idea of a construction site obviously suggests 'gathering', 'assembling', 'work', 'building', and 'making'. Latour is arguing that all things are constructed, and construction has a very particular meaning. I use an example to characterise this. In developing tutorial software, there is an assembling of things human and non-human. The list is extensive: expertise, financing, designs, curriculum, codes, cups of tea, temperature, delays, and bugs. It is only if these things come together in productive ways that the construction progresses. There is perpetual uncertainly during the process of construction. At the beginning, but really at any time, the whole thing might collapse and de-rail or be abandoned. When the project is completed the uncertainly and the memory of the work recedes, the thing stands as if it was always going to be as it is. Latour (2005) points out that the term construction seems an ideal word to describe this process of how a thing comes to be what it is.

Chapter 1 introduced the concepts relating to construction including stabilisation, translation and black boxing. Actor-network theory literature is full of empirical research that traces the construction of 'facts' and 'things' that start from uncertain beginnings (cf. Nimmo 2011; Sørensen 2012). Construction in this sense is not a fabrication, it produces realities. But before anything is real there is *work* involved.

This means that construction has a history that leaves behind empirical traces of relations between human and non-human entities.

Latour (2004) explains that actor-network theory concept of construction is at odds with modernist assumptions about the objective reality of things in the world. This is because construction produces 'facts', 'knowledge', 'material objects', and all phenomena, including *TEL as a field of inquiry*. The actor-network theory concept of construction is also at odds with social constructivism. In Latour's (2005) words construction can "account for the solid objective reality by mobilizing various entities whose assemblage could fail; 'social constructivism' means … that we *replace* what this reality is made of with some *other stuff,* the social in which it is 'really' built." (p. 91 italics in the original). Actor-network theory has some affinity with postmodern and post-structural commitment to relativity, and the techniques of deconstruction and literary analysis described in the literature review in Chapter 2. However actor-network theory is primarily a socio-material understanding of the world so that discourse is understood as not only language and inscription, but also the material form of things.

Latour develops methods for writing accounts of two sets of procedures: "a first set that makes the deployment of actors visible; and a second that makes the unification of the collectives into a common world acceptable to those who will be unified" (p. 256). As Fenwick and Edwards (2010) point out, education has always had material technologies associated with it, and they include in this pen, paper and books. Each technology is already an assemblage, and overtime the history of struggles and construction becomes invisible as the technology is taken-for-granted. Latour's text on methods is about tracing the construction of reality. In other words, how assemblages are constructed and come to endure. His writing on tracing uncertainty and construction offers insights into where to look for data; and how to write accounts of controversies before these are black boxed, or conversely betrayed and side lined or abandoned (Latour, 2005).

On what is data, Latour is clear that data is any form of inscription that leaves a material trace. The world that I am exploring in this thesis is the material world of documents and other media that can be accessed via the internet. I use the term 'source' to describe a location that is accessible on the internet. Sources include, for example, conferences, journals, funded projects sites, online museums and online archives of computing history. Sources like list-servers, discussion boards, and software archives are sometimes not visible on the open web but can be accessed via the internet in databases and other archives. Data comes from sources. Latour extends the term assembling to include data gathering, and (in my view) this captures the uncertain and emergent process of tracing sources and selecting data.

A common critique of actor-network theory is that the process of inquiry, and research methods are obscured by talk of sensibilities (Fenwick and Edwards 2010). Latour (2005) explains this (deliberate) lack of prescription in his substantial methodology text, which works with examples and case studies to demonstrate that research methods can be persuasively emergent. Latour begins by emphasising that he will not list actors, methods and domains because the purpose of the inquiry is to trace how the object of research comes to be what it is. Instead he organises the process of inquiry around controversies which he says are "built upon the major intuitions of the social sciences" (p. 22). The controversies centre on five uncertainties:

- Groups formations: there are many ways for groups to form and survive.

- Action is overtaken: the effects of action are unknown in advance, and there is no way of knowing what will barge in and change things.

- Objects have agency: the types of agencies taking part is not limited to humans.

- How matters of concerns become facts: facts are sources of continuous disputes.

- What it is to be empirical: in science and social science the precise sense in which a study and the world are related is constructed through inscriptions. (adapted from Latour 2005, p. 22).

Table 3.1 Latour on uncertainty and materialisation	
Latour (2005)	Examples of inferred questions
Group Formations (pp.27-42)	What groups are recognised as doing TEL research? Who speaks for these groups? When did these groups emerge?
Action Is Overtaken (pp.43-62)	What entities, (e.g. 'technologies', 'theories of learning', 'pedagogies', 'the learner' and 'learning') are evident in TEL research? How are these conjoined and / or considered the same or different? What and where are the competing entries and relations, and where are the traces of conflict?
Objects have Agency (pp.63-86)	Where are the accounts of technology and remains of physical prototypes from the period when digital technology was experimental, fragile and uncertain?
Facts and Concern (pp.87-120)	How are research concerns in laboratories and research institutes translated into 'facts'? What is involved in the making of facts e.g. theories of learning, software routines, and configurations of TEL technologies?
Writing Risky Accounts (pp.121-140)	What forms of digital notebooks can track the provenance, archiving and analysis of mixed media data? How can software (e.g. NVivo 10, Mendeley 1.15) be configured to log and track changes in meta data file, analysis codes and composite accounts?
Rendering associations intelligible (pp.159-219)	What is the vantage point? What and where is TEL research at that time and place. Where do constructions of 'technology', 'learning' and 'enhancements' as stabilised at the vantage point, come from?
For a full version of this table see Appendix B: Table 1	

In terms of my TEL questions, namely, *What is TEL research?* and *Where does TEL research comes from?*, I assume that there was a time when there were no TEL research groups, TEL projects or TEL researchers; no digital technologies, no facts about learning or enhancement, and no definitive sense of evidence or research method. The point here is that although there is a contemporary field of inquiry called TEL research this had uncertain beginnings.

Latour shows that these uncertainties have methodological implications, and his argument explains the socio-material construction of realities. Uncertainty generates controversies in which actors (human and non-human) are at work forming alliances. The work involves translations in which alliances are formed, and 'things' human (e.g. identities) and nonhuman (e.g. technologies) come to 'exist' as effects of their relations. Some assemblages (of relations) don't survive, while those that endure construct realities. The first part of Latour's (2005) book on methods, describes strategies for tracing groups, actions, objects, facts and methods of discovery before they are consolidated and stabilised into taken-for-granted realities. He argues that it is only after the detailed work of examining controversies, and writing accounts of these, that that it is possible to reassemble these accounts into findings.

I used the structure of Latour's argument on methods to infer guidance on tracing uncertainties in relations to my specific TEL research questions (see Appendix B: table 1). A reduced summary of this is illustrated in Table 3.1. Latour's guidance is also interesting in advocating writing and other forms of inscriptions as an instrument of research. He uses diagrams, narratives, cartoons, images, and bricolage to describe the research process and what emerges from it. He advocates the use of records, themes, and timelines which describe (leave traces of) how data is collected, selected, organised, and interrogated (See Appendix B: table 1). This provides a wealth of examples of how data is gathered, analysed and presented. These ideas are used extensively in the empirical chapters.

One of the interruptions in TEL history that I described in Chapter 1 was the availability of computers, the internet and the web. At this stage digital technology stabilised and its effect was difficult to reverse. This led me to conclude that my research questions have to engage with the materialisation of technology (this is taken up in Chapter 4). However, although Latour uses discourse analysis in his empirical studies (Latour & Woolgar 1986) this does not feature explicitly in his methodology text, and for this I turn to Foucault.

Foucault on discourse and regularities

In his Archaeology of Knowledge Foucault (2002) consolidated his approach to discourse analysis on textual archives. He drew on his previous publications[14]: *Madness and Civilization* (2001a), *The Birth of the Clinic* (2003) and *The Order of Things* (2001b) to illustrate his method, and he makes constant reference to specific studies from these texts. This specificity of investigations is important because in doing so Foucault demonstrates non-deterministic inquiry without prescribing a definitive method.

Much has been written about the problems of working with Foucault's research method (Kendall & Wickham 1999; Rabinow & Rose 2003), and his reluctance to commit to a stabilised version of his own approach (Graham 2005; Harwood 2001). It is true, that Foucault's work is difficult to simplify as he is constantly stepping back, questioning and shifting in response to his own objections. His account of his methodology is no different; he puts it like this:

> Hence the cautious, stumbling manner of this text: at every turn, it stands back, measures up what is before it, gropes towards its limits, stumbles against what it does not mean, and digs pits to mark out its own path. At every turn, it denounces any possible confusion. It rejects its identity, without previously stating: I am neither this nor that. (Foucault 2002, p. 18).

Rather than berating this ambivalence as a weakness, I argue that Foucault is as clear as it is possible to be given the kind of question he is asking and the sensibilities of non-deterministic inquiry that he is demonstrating. He writes: "Those large groups of statements with which we are so familiar, which we call medicine, economics or grammar – I have asked myself on what their unity could be based" (Foucault 2002, p. 41). This is not unlike my question about TEL research.

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[14] Current reprints are cited

Table 3.2 Foucault on discourse and regularities	
Foucault (2002)	Examples of inferred questions
The formation of enunciative modalities (p. 55) "Who is speaking? Who, among the totality of the speaking individuals, is accorded the right to use this sort of language?" (p. 5)	What are the unites across statements in which the author is named, characterised and authorised? When and where is the author more than one, e.g. a funding body, professional association or institution?
The formation of the object (p. 44) "We must now list the various directions that lie open to us, and see whether this notion of 'rules of formation' ….can be given content." (p. 44) "these are not the same in different societies, at different periods, and in different forms of discourse…" (p. 45)	How are statements organised to make material design possible? What regularities are involved across production of technologies, vocabularies, ordering and classifications? What rules are discernible across sites where TEL research is said to take place? How are boundaries of TEL research produced by regularities.
The formation of the concept (p. 62) "Could a law not be found that would account for the successive or simultaneous emergence of disparate concepts ….but not as a virtual deductive edifice ….but more like describing the organisation of the field of statements where they appeared and circulated." (p. 62)	Do some of the design concepts 'escape' and circulate in talk about education and learning? How do concepts from learning theory get enacted in technology design? What concepts from technology design are drawn into descriptions of learning? What regularities describe these circulations and translations?
The formation of the strategies (p. 71) "Such discourses….give rise to certain organisations of concepts, certain regroupings of objects, certain types of enunciations …… Whatever their formal level may be, I shall call these themes and theories 'strategies'. (p.71) Determine diffraction of discourse, where objects and concepts are regarded as incompatible; and then characterised in equivalent terms, and systematically come to form discursive subgroups, alternatives and oppositions rather than a "defect of coherence" (p. 73)	What themes and theories characterise the shifts in the discourse of TEL research? How are these materially embodied? Where are the recurring themes and theories? What strategies are used to characterise 'the other' (e.g. rhetorical tactics like circular argument; false opposites; appeal to emotion, authority, status, and history; and setting up straw opposition)? What are the rules of engagement in forming alliances and characterising opponents?
For a full version of this table see Appendix B: Table 2	

In answering his own question Foucault discusses what might be included – objects, normative types of statements, concepts and themes – and then demonstrates that these are invariably messy and uncertain. The analysis should therefore extend, he argues, to systems of dispersion, which make things connect and work to have some recognisable unity. This argument can be extended to examining how the unity of *TEL as a field of inquiry* is possible, and it has parallels with Latour's (1993) account of hybrids and purifications.

Latour's methodological guidance is about tracing associations between humans and nonhumans and the stabilisation of associations into alliances. Foucault's methodological guidance is about the productivity of discourse, what it is, how it works, and is embodied in the design of technologies and buildings (Foucault 1995). Foucault (2002) writes that systems of dispersion can be described in two ways:

- As discourse formations: "Whenever one can describe, between a number of statements, such a system of dispersion, whenever, between objects, types of statements, concepts, or thematic choices, one can define a regularity (an order, correlations, positions and functioning, transformations), we will say for the sake of convenience, that we are dealing with a *discursive formation"* (p. 41 italics in the original).

- As rules or regularities which make discourse formations possible and vulnerable: "The conditions to which the elements of theirs division (objects, mode of statement, concepts, thematic choices) are subjected we shall call the *rules of formation*. The rules of formation are conditions of existence (but also of coexistence, maintenance, modification, and disappearance) in a given discursive division" (p. 42 italics in the original).

The statement is central to Foucauldian discourse analysis. A statement, Foucault (2002) writes, does not exist in the same way as language, although "it is made up of

signs that are definable in their individuality only within a natural or artificial linguistic system" (p. 97). Nor, Foucault continues, is a statement an object that can be touched and perceived. With all the things a statement is not, it seems that Foucault makes two important points. First statements stand for what constitutes legitimate and authoritative knowledge and this means that that *statements are data* that can be examined to understand how legitimacy and authority are produced. Second, statements are functions that cuts across domains, structures and disciplinary boundaries. Statements are ontological presuppositions that are organised by regularities and goals that render regimes possible, understandable and also vulnerable (Glynos & Howarth 2007).

I have used the structure of Foucault's argument on methods to infer guidance on describing discourse formations and regularities in relations to my specific TEL research questions on *what is TEL research and where it comes from* (see Appendix B: table 2). A summary of this is illustrated in Table 3.2. On the left of Table 3.2 is Foucault's methodological guidance on describing regularities of discourse and rules of formation, and in the right column I reframe Foucault's guidance. These questions are a way into examining specific groups of statements about TEL research from the period between 1945 to 2012. Foucauldian discourse analysis, reframed in these questions, features in chapters 4, 5, and 6 and in each case the data leads to quite different accounts of *what TEL research is and where it comes from*. This is because materialisation of discourse in digital technology changes what TEL research is. The relations between 'materiality' and 'statements' is Foucault's work is well documented (Foucault 2002; Rose 2007) and this is discussed next.

Foucault (2002), reminds us that a statement is "invariably endowed with a certain materiality, and can always be situated in accordance with spatio-temporal coordinates" (p. 97). In other words, a statement is always embodied in material and the form of that material, and embodiment effects how it works. Hunter, quoted in Kendall and Wickham (1999), explains Foucault's insight with a pedagogical example:

Consider a simple algebraic formula for expanding a series $y=2x + 5$, if $x=2$, then the series runs 9, 23, 51 etc. Now at this point in the expansion of the series, what does it mean to 'think' of the next number? There is no question of this discursive operation expressing my thought of the next number, a thought which exists independently of the operation of the mathematical discourse. For this to be the case it would have to be possible to think of the next number without performing the calculation … forming the calculation materially produces the criteria for what we will call 'the next number. (pp. 35–36)

In this scenario, materiality is embodied in the representation of an expanding series, and inscription devices, which can be, for example, paper and pencil, textbooks, a calculator or modelling software. Each materialisation has different effects on what counts as learning and what is learnt.

Latour and Woolgar (1987), in their study of science in action in laboratory life, offer a dynamic account of how discourse is materialised. They show that a great deal of research activity is connected to transcription or inscription. As they put it, researchers spend most of their days "coding, marking, altering, correcting, reading, and writing" (pp. 48–49). In their accounts, laboratory equipment is interpreted as "inscription device[s]" that have the sole purpose of "transform[ing] a material substance into a figure or diagram" (p. 51). TEL research has produced discursive objects that are physical and conceptual, for example, technologies and theories of learning; and these objects are in turn performative in changing what is possible to think and do, find and discover, talk about and challenge. With his emphasis on uncertainty and traces, Latour can be read alongside Foucault to examine how discourse is materialised in TEL technologies. This is taken up in Chapter 4.

The combination of guidance from Foucault and Latour emerges as powerful in a different way once TEL technology stabilised into affordable consumer products. Empirically this means examining how digital technologies and other networks connect, partially connect or fail to connect, how assemblages that are relational networks form new alliances that may be severed or betrayed. This is also how the

actor-network theory term *translations* is defined (Fenwick and Edwards 2010, p. 146). This suggests that the discourse history of TEL research is also about how digital technologies have changed the discourse and material realities of TEL research, including, for example, educational policy, funding of TEL research, design of TEL research and conceptions of learning and pedagogy. This is taken up in Chapter 5.

Law on coherence and non-coherence

In After Method: Mess in Social Science Research, Law (2004) sets out to develop a vocabulary for thinking about research methods in a world in which multiple realities can exist at the same time. For Law, the world, including socio-material phenomena, is slippery, constantly changing, contingent, emotional and textured in different ways. He asserts ontological variety and sets out to show how this can be detected in the co-existence of fragmented, partial, overlapping, and contradictory accounts of research objects and phenomena. Fenwick and Edwards (2010), drawing on Law, describe the effects of rationalised methods in education research:

> Research methods are designed to smooth away and simplify the messy lumpishness and most interesting complications of the world, in well intentional efforts to *know* them and make things clear. In other words, research itself purifies through its enactment. Furthermore, our research methods tend to enact as well as to *describe* the things being researched, without always recognizing the implications of these interference. (p. 144 italics in the original)

The literature review of TEL as a field of inquiry presented in earlier chapters, invokes this sense of certainty and the coexistence of uncertainty across many different worlds. Law (2004) describes the simultaneous existence of many realities as multiplicity . Multiplicity is "the simultaneous enactment of objects in different practices, when those objects that are said to be the same." (2004, p.162). Law is clear that this is not the same as pluralism, "in which there is no interactions between

multiples and realities proliferate without restraint," (ibid., p.160). Nor is it the opposite of, "the converse commitment to ontological singularity in which the world is taken to be singular and consistent." (ibid., p. 160). Multiplicity in this sense is metaphorically fractional that is "more than one but less than many" (ibid., p.160). These ideas resonate with the problematic of TEL research in this thesis.

Table 3.3 Law on coherence and non-coherence	
Law (2004)	Examples of inferred questions
The hinterland of science knowledge practices. "If realities 'out-there' and new knowledge of those realities 'in here' are to be created than practices that can cope with a hinterland of pre-existing social and material realities also have to be built up and sustained." (p. 13)	What is being gathered from the hinterland (i.e. discourse history)? What is taken-for-granted, common knowledge, black boxed, simplified, reduced, and hidden? Account for differences in depictions of the 'real'. What different histories are compounded into coherence.
Fractional accounts and fluid results "Fractionality: is a metaphor for expressing the idea that realities (and so their hinterland) are more than one and less than many. The idea that hinterlands partially intersect with one another in complex ways. A way of avoiding two equally unsatisfactory alternatives…pluralism….and ontological singularity….." (p.160)	Look for connections and interferences or separation between different 'realities'. How does this 'work' in action. What is same and different? How do the different paradigms connect or partly connect? How do accounts of TEL research translate each other?
Multiple worlds and different sites "Multiplicity: like differences , the simultaneous enactment of objects in different practices, when those objects that are said to be the same. ….this arises because practices are endlessly variable and differ from one another….and overlap in many and unpredictable ways…" (p. 162)	How are objects like 'learning', 'technology' and 'enhancement' enacted across different sites of TEL research. What forms of data analysis can trace enactments at different archival sites. Can composite accounts capture differences and simultaneous enactments of sameness?
Modes of ordering/logics. "…if we attend to the practices we tend to discover multiplicity….*but not pluralism*"(p. 61 italics in the original).	How do differences work so that they are routinised, unsurprising parts of the discourse regime? What are the forms of ordering that help make TEL research recognisable as a field of inquiry?
For a full version of this table see Appendix B: Table 3	

I began with the puzzle that TEL research is seemingly an established field of inquiry but it is also many contradictory and partially connected assortments of technologies, people and ideas.

Recently Law et al. (2013) have reframed multiplicity with empirical studies to demonstrate that "practices that generate purity effects are also non-coherent" (p. 3). Law's term for this effect is "mess" (Law 2004, p.2). However, non-coherent is not incoherent. Incoherent is a normative label, a way of talking about failure or chaos. Non-coherent suggests that different logics are at work; that both coherence and non-coherence are productive. There are parallels here to Latour's account of hybrids and purification (see Chapter 1 and Latour 1993) and Foucault's (2002) account of discourse as powerful and vulnerable. The methodological challenge is to find ways of thinking about and understanding the productivity of mess and of handling the TEL bias towards regimes of truth. Law's textbook on methods (2004) describes the productivity of mess in terms of modes of ordering (also referred to as logics). These overlap with Foucault's concept of discourse formations and regularities.

On the concept of orderings, Law (2000) writes: "In the context of classic theory, they are closest to Foucault's notion of discourse. This is because they are arrangements with a pattern and their own logic, except, as I have already noted, they are smaller." (p. 22).

The structure of Law's argument on methods was used to infer guidance on describing the productivity of coherence and non-coherence in relation to my specific TEL research questions (see Appendix B: table 3). A summary of this is illustrated in Table 3.3.

Following this guidance two observations are worth noting. First, in examining mess it is useful to juxtapose different accounts which describe objects that are said to be the same, but are enacted differently at different times and in different locations and practices. Law draws on work by Anne Marie Mol (2002) to demonstrate how to juxtapose accounts. Mol's book is about medical practices that generate the

paradoxical object, the body multiple. Her question is this: What is lower-limb atherosclerosis? She describes how lower-limb atherosclerosis is enacted as investigation of the body in the surgeon's consulting room, in the pathology laboratory, and the radiography lab. In each location the combination of instruments, medical procedures, and hinterland of customs and practices assembles a different version of the body reality. This recourse to multiple accounts is demonstrated in other domains, for example, farming, healthcare, politics and religion (Law et al. 2013). It is a useful technique in demonstrating non-coherence that also sets the stage for writing accounts of how these different realities are coordinated (or not). In Chapter 6, I describe these as forms of ordering, and note that different vocabulary (e.g. logics, modes of ordering, and discourse regularities) stand for the same idea.

The second observation is that in all the accounts of how non-coherence works, attention is focused on the work which performs different realities into a discursive coherence. Law et al. (2013) are careful to point out that while there may be similar logics that hold different accounts together (or not), because 'how this works' is an empirical question there are no grounds for supposing that any list will be complete. Law (2004) puts it like this:

> To talk of enactment, then, is to attend to the continuing practice of crafting. Enactment and practice never stop, and realities depend upon their continued crafting – perhaps by people, techniques, text, architectural arrangement, and natural phenomena. (p. 59)

Law (2004) is not saying there is no room for conventional research methods: "The problem is not so much with research methods themselves, but the normativities that are attached to them in discourses about methods" (p. 4). Latour and Foucault offer guidance on describing how discourses stabilise to produce regimes of truth, and I extend this to the material products of TEL research. What we need, according to Mol (2002) and Law (2004), are descriptions of coherence and non-coherence, and how these work in practice. They demonstrate the multiplicity of realities and how differences are regulated, managed, policed, smoothed over, ignored, and in other

ways are productive. This is comparable to what Foucault describes as the productivity of discourse, and Latour calls the construction of realities, but it is different in focusing on narrative accounts that explicitly draw attention to mess.

Drawing on these influences from Latour, Foucault, and Law, I can now signpost the scope of the empirical chapters. How discourses are materialised in technology is taken up in Chapter 4. The translation effects of materialisation once it is stabilised is taken up in Chapter 5. Law's influence raises the possibility of producing multiple co-existing enactments of TEL research each of which is productive. This is described as forms of ordering and is taken up in Chapter 6.

The archive in question

The title of this section is intended to recognise that the archive is not the same for all disciplines, domains and research questions. What it is and what is does is disputed and itself an area of active research. This introduction reviews this research literature before moving onto the practicalities of assembling and organising an appropriate TEL research archive.

In Chapter 1, I described the UK TLRP/TEL research programme and explained why and how it prompted the research questions in this thesis. The main social science funding body in the UK, the Economic and Social Research Council (ESRC) stipulated two data-related conditions for funding. First, there had to be a check to find out if suitable data was already available and could be reused, thereby saving costs; and second, any data from the funded project had to be 'offered' for archiving and future reuse (ESRC Datasets Policy 2002). The dataset had to have been submitted to QUALIDATA, the Qualitative Data Archive Resources Centre at the University of Essex , which was partly funded by ESRC in 1994 (Corti & Blackhouse 2005). If the dataset was accepted and inserted into the archive, this was recorded in the final project report as a mark of success and prestige. Derrida (1996), writing about the origins of the word archive, traces its Greek roots to archons the home of the magistrate who had the right to make laws, keep the peace, control the

archives and decide what was recorded and left out. QUALIDATA is in this sense a conventional archive: authorised, administered, repaired and managed by a powerful organisation. This is one source of traces of historical data about TEL, but it comes with a caveat that it is an official store of knowledge. There are other kinds of archives that leave different kinds of traces.

The role of QUALIDATA, as an example of an archive envisaged as a store of managed social science knowledge, suggests that archival practices are no longer limited to history or the humanities. This has not always been the case, as Geiger et al. (2010) observe:

> Whereas during the second half of the 20th century we can trace a clear demarcation between past-centred humanities disciplines, and present-orientated social science ones, we can increasingly recognise that social sciences themselves have been historical agents. Their traces, or relics, deposited in archives can be read in a way which muddies any clear boundaries between history and the social sciences. (p. 5)

It is easy to show that the archive has become central across a range of disciplines and domains, for example, sociology, anthropology, and performance studies (Geiger et al. 2010), education (Education Evaluation QUADS Project 2005), computer science (IEEE Global History Network 2013) and TEL research (TEL Programme Database 2013). Newer research practices draw on archived material as data to understand the present. Examples from Science and Technology Studies extend this to include the history of technology innovations. I too draw on archival data to examine my research questions; however, to do this I have to recognise that the official archive is not the only source of historical data, and it is not neutral.

Paradoxically, the formalisation of archives as stores of research knowledge has emerged alongside critiques of what it is. This is evident in two respects. The first is in the questioning of conventional understandings of the archive as an unproblematic store of human history (Burton 2006; Geiger et al. 2010, 2006; Manoff 2004;

Steedman 2002). As Steedman observes, Derrida's (1996) 'Archive Fever' provides a "theoretical perspective on the institution of the archive, the practices of reading and writing attendant on them, and the systems of regulations and coercion they (sometimes) underlined" (Steedman 2002, p. 2). She also notes that Foucault raised the 'question of the archive' as early as the 1960s. The second is technological innovation, in particular digitisation and the internet, which have opened up the archive to a larger constituency. Beyond the traditional archivist, any group or individual can publish and preserve materials on the internet (Brugger 2005; Lannom 2012).

A naïve response to the destabilising of traditional archives would be to say that the internet is already a preservation system, and a collection of links is enough to build a new view of this universal internet-as-archive. However this is not the case:

> Forty percent of the material on the internet disappears within a year, while another forty percent has been changed, which is why today we can only expect to find twenty percent of the materials that was on the Internet one year ago. (Brugger 2005, p. 11).

Moreover, website archives published by enthusiasts/authors and small organisations, but not managed by archivists, are liable to be move or removed, and at some point the technical infrastructure will not be supported. An example is the TLRP virtual research environment (SAKAI). This was populated with records of funded TEL research until 2011, when its funding was withdrawn and overnight the material disappeared from the internet. Where the source is tied to data aggregation tools that collect materials thematically (e.g. in TED archives – the not-for-profit Technology, Entertainment and Design), it is the reliance on commercial aggregator tools that is unpredictable.

While the conventional archives dedicated to TEL research do not exist, TEL research features in many archives on the internet and on the internet-as-archive (Bishop 2008). One of the qualities of the internet-as-archive is that it can be

deployed to restore connections that produced the documents that are in official archives. This is a kind of archaeology of the document and multimedia. For example, the August 1994 Communications of the ACM published a peer reviewed article which described the World Wide Web (Berners-Lee et al 1994.). This publication is part of the ACM online archives. But the first version of it as a CERN internal document bid for funding was found in the internet archives of the World Wide Web Consortium (Berners-Lee 1989). The idea was referred to as the MESH, and in the ACM paper it was called 'World-Wide Web (W3). Before any document about MESH was published, the code from the prototype was widely downloaded. In addition, the people who produced the original documents and technologies in the official archives are still adding to original specifications, and generating commentary that has been captured in lectures, interviews and writings, thereby continuing to populate the internet (-as-) archive. This is important because it is a way of assembling materials which goes beyond the curated archives but is still part of the discourse history of TEL research.

Earlier in this chapter, I explained that the world I am exploring is the material world of documents and other media that can be accessed via the internet, including digital archives managed by archivists and also (to paraphrase the quote from Steedman at the beginning of this chapter) the mad fragments that no one intended to preserve and just ended up on the internet-as-archive. It is as well to note the problem of vocabulary that stems from the questioning and opening up of archival inquiry. The problem is evident in the conflicting provenance of terms that have already been used in this section. Consider, for example, four different practices:

1. In social science methodology texts (e.g. Bryman 2012; Gorard & Taylor 2004), terms like data, datasets, data pool are referents for generalised constructs. For example, 'a document', 'interview transcript', 'photograph', 'blog entry', 'software code', in fact any entity that can standalone as exemplar of its type, can be data and described as data item. A collection of data items is described as a dataset. The places from which data is taken is the data pool. The archives (e.g. ESDS Qualidata archive) are databases that only hosts data that has been peer

reviewed and conforms to documented ethical standards (ESDS Economic and Social Data Service Annual Report 2010).

2. In methodology texts from the humanities disciplines, archives are organised into collections by archivists, and the researcher will select 'sources' from across the different archives and collections, depending on the focus of inquiry and the genre of discourse analysis (Rose 2007; Phillips & Hardy 2002; Nead 1990; Tonkiss 2004). In these domains, the 'source' is the equivalent of 'data item' in the first example, and 'the collections' are data pools.

3. Science and Technology Studies use the terms 'material', 'cases' and 'ethnographic accounts' to describe the equivalent of 'sources' and 'data'. As with the first example, what counts as data is wide open but the difference is that the material (called 'data item' in example 1, and 'source' in example 2), is mobilised when the researcher traces connections with other 'sources'/'data' to write composite accounts of these connections. The researchers' writings, for example, their notes, examples, illustrations and composites, are then both part of the dataset and part of writing the findings. A useful, pragmatic interpretation of terms like 'assemblages' (Latour 2005) and 'gathering' (Law 2004) is to regard these as part of the dataset.

4. Finally, qualitative data analysis tools also adopt their own vocabulary. NVivo 10, which was used during data gathering and analysis and so some of the labels on the screen shots later in this chapter, adopts a different structure. The 'project' is a container, while sources are folders that contain (data) items. Nodes are segments of analysis. For example, a relationship is a node connection that names a relationship between two data items, and a case is a node with attributes. This is relevant because I used NVivo 10 to manage the breadth and detail of the empirical inquiry. I shall return to this later in the chapter.

While it is important to acknowledge the vocabulary differences, to prescribe a vocabulary is contrary to the spirit of non-deterministic inquiry. The approach that is favoured is to use vocabulary that is self-evident in the context of use. For this thesis, the archive in question is the iterative process of finding, gathering, selecting,

storing, organising and analysing data so that the accounts of TEL research and the discourse history of TEL research in Chapters 4, 5, and 6 are persuasive and transparent.

Assembling the data

The general advice when dealing with archival data is to invest in "the kind of browsing that leads to serendipitous finds. Some of the most interesting discourse analyses are interesting precisely because they bring together, in convincing ways material that has previously been seen as quite unrelated" (Rose 2007, p. 149). Following Rose's advice implies not being constrained by notions of genre and technologies. Eclecticism is demanded by the intertextuality of discourse, what Green (1990), echoing Foucault, describes as "a coherent pattern of statements across a range of archives and sites" (p. 3).

To act on this, I developed three processes.

- First, by studying internet search processes, and advanced information retrieval (Stacey & Stacey 2004), I developed a process for tracking search terms and tracing references across documents.

- Second, because it was clear that even during the process of gathering data from the internet it was likely to disappear overnight (see earlier discussion on archives), I set out to capture imprints of any material that was included in the dataset.

- Third, I devised a system to streamline the judgements necessary when drawing on historical and internet materials as data. This involved paying attention to the selection of appropriate sources, identifying when the source was produced, by whom and for what purpose, scrutinising the validity (it is what it claims to be), as well as ensuring that data protection and copyright issues were addressed systematically.

Much of this would have been impossible without the data management and analysis software NVivo 10 , and the referencing software Mendeley .

Guided by contemporary practices in qualitative data analysis (Bazeley & Jackson 2013), I used the NVivo 10 qualitative data analysis software to manage the process of keeping track of sources and the later analysis statements and codes. As is common to all scholarly writing, there was a convergence between the processes of data gathering and tracking citations and references. The open-source software Mendeley was used for referencing because this tool is connected to a large network of scholars from science, social science, education and humanities. NVivo is proprietary and expensive and the web version is designed for large well-funded research teams. Mendeley is web-based and simpler to share and maintain. Both systems were run in parallel during the empirical work, but in the final stages of writing, the dataset was transferred to Mendeley because it is a more sustainable platform for access to the thesis archive.

The work of assembling the data was iterative. Initially this involved a number of parallel activities. One was to follow leads by examining the themes, references and key terms from the UK TLRP/TEL call for funding documents (2006, 2007). Another was is compiling a list of sources which combine references to 'digital technology' and any combination of 'learning, education, teaching or pedagogy'. This threw up a daunting list of sources, for example, museum sites and internet archives, conference and journal back copies, government reports, professional association website archive, open source archive, citizen scholarship, aggregated site (invited), aggregated site (self-publishing), portals, and materials published by research centres, authors and teams, and international consortiums. A third line of activity was to search for the history of the various groups that were identified in the literature review, for example, 'e-learning' 'cognitive science' and 'computer supported collaborative learning'. A fourth line of activity was influenced by the literature review. There I had found a limited literature on the history of TEL. In response, I shifted the focus to the histories of 'digital technology', 'research into learning' and 'education'.

After a period of ad hoc collecting it became possible to classify sources into types. Material examples of TEL research that were discovered through searching, browsing and tracing include documents of various genres, images, diagrams, design reports and descriptions of technologies as well as archives of working software. Figure 3.1 shows a list of data sources as a screen shot from NVivo. The sources include a range of types: (1) traditional archives in museums; (2) Peer reviewed publications archived back copies; (3) back copies of reports archived by Professional bodies and research organisations; (4) archives maintained by individuals and hobbyists groups; and (5) media aggregator sites. Some of these sources are traditional archives managed by gatekeeper archivists, while others are aggregated by search engines and related tools. NVivo 10 supports multimedia capture of content from websites, databases, social media sources from any location accessible on the internet. This made it possible to take a copy of the digital material and store it in the program database.

Earlier I referred to developing processes for tracking search terms and tracing references across documents. This was realised in two strategies: tracing statements and keywords; and tracing references.

(1) The first strategy was to follow chains of statements. This involved experimenting with TEL research-specific specialist words and phrases and noting how these shifted over time or stayed the same. Online Indexes made it possible to search multiple online archives. Moreover, metadata is increasingly composed of digitally structured records that work within national and international standards (NISO Framework Working Group 2007), but also incorporate metadata tags (e.g. keywords) which can be assigned to any information. Metadata controls search results from database queries. Tagging makes data accessible to search engines irrespective of quality, authenticity or accuracy. This means that judgement is necessary, but at the same time it is possible to search across disciplines, locations and time periods (e.g. via key word searches for TEL publications and conferences, research centres, technologies and designs, as well as TEL organisations, funding, and people). In this way it was possible to trace shifts in terminology from

programmed instructions, programmed material, and programmed learning; to e-learning and computer based training; and then technology enhanced learning (Hammond 2003, Underwood & Luckin 2011, Vaney & Butler 1996).

(2)   The second strategy was a more concentric working outwards to trace connections. As a response to the breath of material required by discourse analysis, Rose (2007) recommends selecting a document (she calls this a source) as the starting point. In this respect the UK TEL call for funding document (2006) is an obvious choice for three reasons. First, the Call can be regarded as a nexus which assembles the network of associations that characterise TEL research at that time in the UK and beyond. Second, the Call is an outcome of competition and conflicts in the field of TEL and is therefore a temporary stabilisation. Third, the Call is in the public domain, and it has attracted attention from many different groups that self-identify as TEL researchers. The first page the documents refers to a second Call in 2007. Taken together, the statements in both Call documents are indications of what is broadly included in the field of TEL research.

The search was consolidated when the same material started to be rediscovered. For example, links were found to organisations, newsletters, trade articles, learned societies, funded projects, journal, conference, case studies, published papers, software, reports, international societies, and special interest groups minutes. The Call for Funding document (2006, 2007) is connected to projects that were funded at the time. After 2009, the TEL programme website has references to technologies that were not on the scene in 2006, for example, "funded TEL projects websites, TEL databases, evaluation videos, online information gaden, tweets, blogs, downloads; interactive apps, and 'envisioning the future' policy reports" (TEL website[15] October 2012).

Given the conceptual resources that informed this assembling process, there was no expectation of finding a coherent, singular or unified field of TEL. The combination of powerful software (including NVivo) and accessibility of material on internet-as-

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[15] www.tel.ac.uk

archive changed the research process, but Latour's (2005) description is still pertinent:

Users of social science seem to consider that its rather straightforward to assemble, invoke, convoke, mobilize, and explain the social. Practitioners of social science know how painful, costly, arduous, and utterly puzzling it is. The 'easy' social is the one already bundled together, while the 'difficult' social is the new one that has yet to appear in stitching together elements that don't pertain to usual repertoire. (p. 165)

This is not a problem of methods "hygiene" (Law 2004, p. 9), meaning the answers are not external to the research process. Therefore what is required is my intervention as the researcher (in collaboration with my tools and materials) to create order in deciding how to organise the data and limit the scope of analysis.

Collections and analysis

I have described the process of gathering the data first, but this was not a sequential process. Although the material in NVivo (554MB) was extensive, what was added and removed continued to be reviewed. Over a period of months I was constantly being pulled into different worlds, and everything seemed relevant and interesting – visualisation and cognitive overload, open source, virtual learning environment and learning theory, performance audit, virtual reality, interactive design, and on and on – it was all TEL in some way. Should I have rationalised what data to focus on and made these decisions earlier? Writing about research practices, Law (2002) describes the experience of being dazzled. About his experience of field research at Darebury Science Laboratory, he observes: "But then, as time passes, things started to change … dazzle started to diminish in part because I began to note different kinds of patterns" (p. 108). Researchers, he argues, detect patterns by focusing on similarities between instances while ignoring other possibilities

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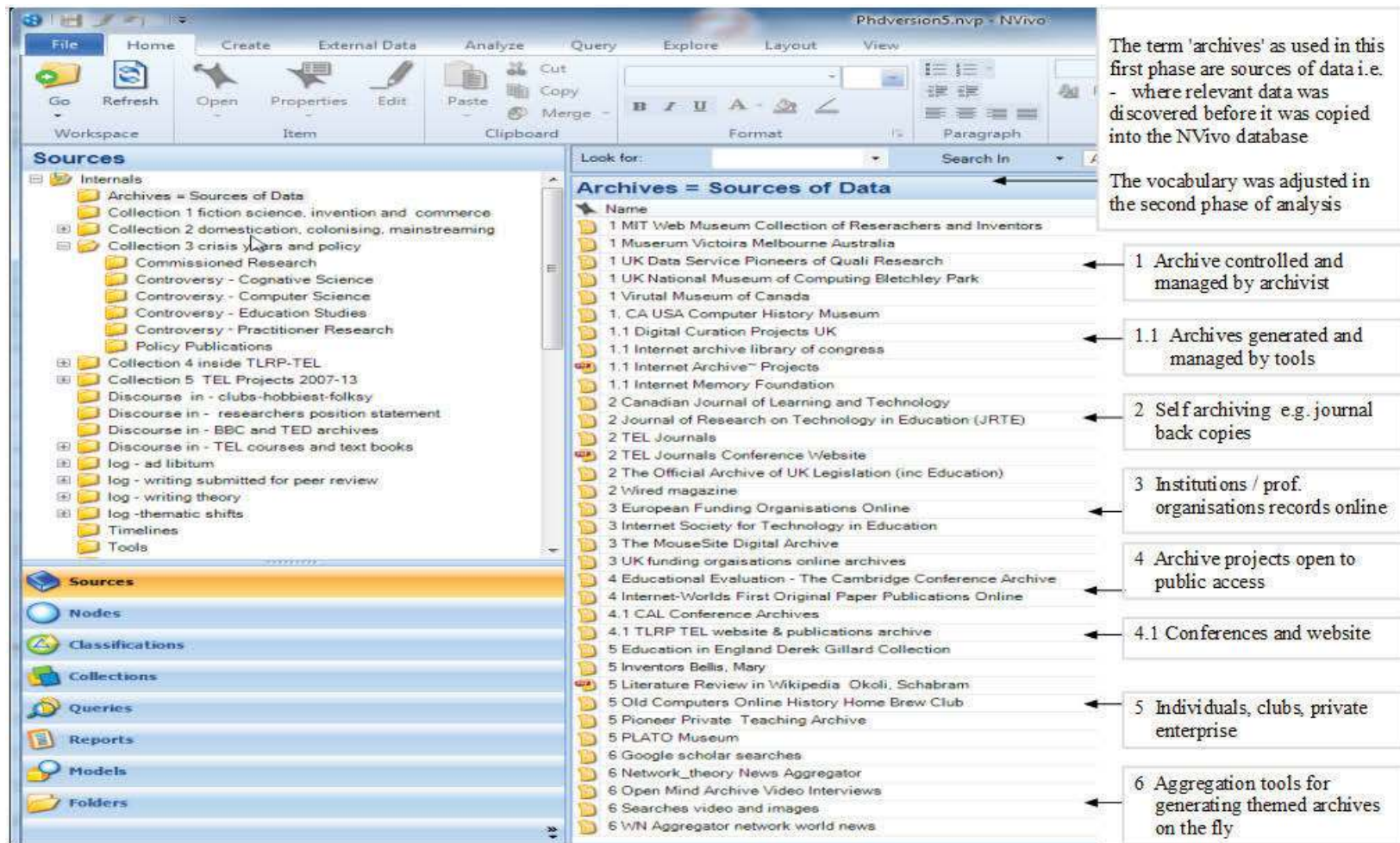
Screen shot from NVivo documenting archives as sources of data organised by type, and folders as sources of data stored internally in NVivo

Figure 3.1   NVivo illustration of data categories and organisation structure.

Screen shot from NVivo illustrating the vocabulary associated with data gathering, classifying and analysis

Figure 3.2   NVivo illustrating the vocabulary and working with data.

After a period of being overloaded with possibilities, patterns began to emerge in two ways: first, by looking for what Foucault calls the formation of enunciative modalities, in other words, regularities that link documents and other materials together with all the appearance of authority and legitimacy; second, by looking for historical shifts which interrupt discourses that for a time are taken-for-granted – what Foucault calls point of diffraction (see Table 3.2 and Appendix B: table 2). Within NVivo 10 this process took shape physically as three types of folders:

1. Folders with material from the different phases of TEL research in which TEL research (often with different names) emerged through connecting, partially connecting or failing to connect with other entities, humans and nonhuman. This history was used to introduce the field of TEL in Chapter 1. In Figure 3.1 these are the folders labelled 'Collections …' in the Sources menu.

2. Folders that are electronic versions of emerging themes across the collections. In Figure 3.1 these folders are labelled 'Log …' in the Sources menu, following Latour's advice on tracing action via logs (see Appendix B: table 1, 18–22).

3. Folders with examples of material where the TEL discourse is productive in being transported across time and space. In Figure 3.1 these are the folders labelled 'Discourse in …' in the Sources menu.

On a more mechanical level, the idea of patterns is useful to describe the iteration between analysis and design that characterised the process of recording information about materials in the folders. An example list of data (in one folder) is shown in Figure 3.2 (on the left). In NVivo vocabulary every piece of data is called a document. Each document in NVivo was scrutinised to determine its validity and features. A document in NVivo can be associated with a metadata table called document properties. Figure 3.2 shows a list of documents (left), a copy of the document stored locally (middle), and the information about the document recorded in the document properties table (right). The metadata table was used as one way of interrogating the documents and allocating them into one or more collections
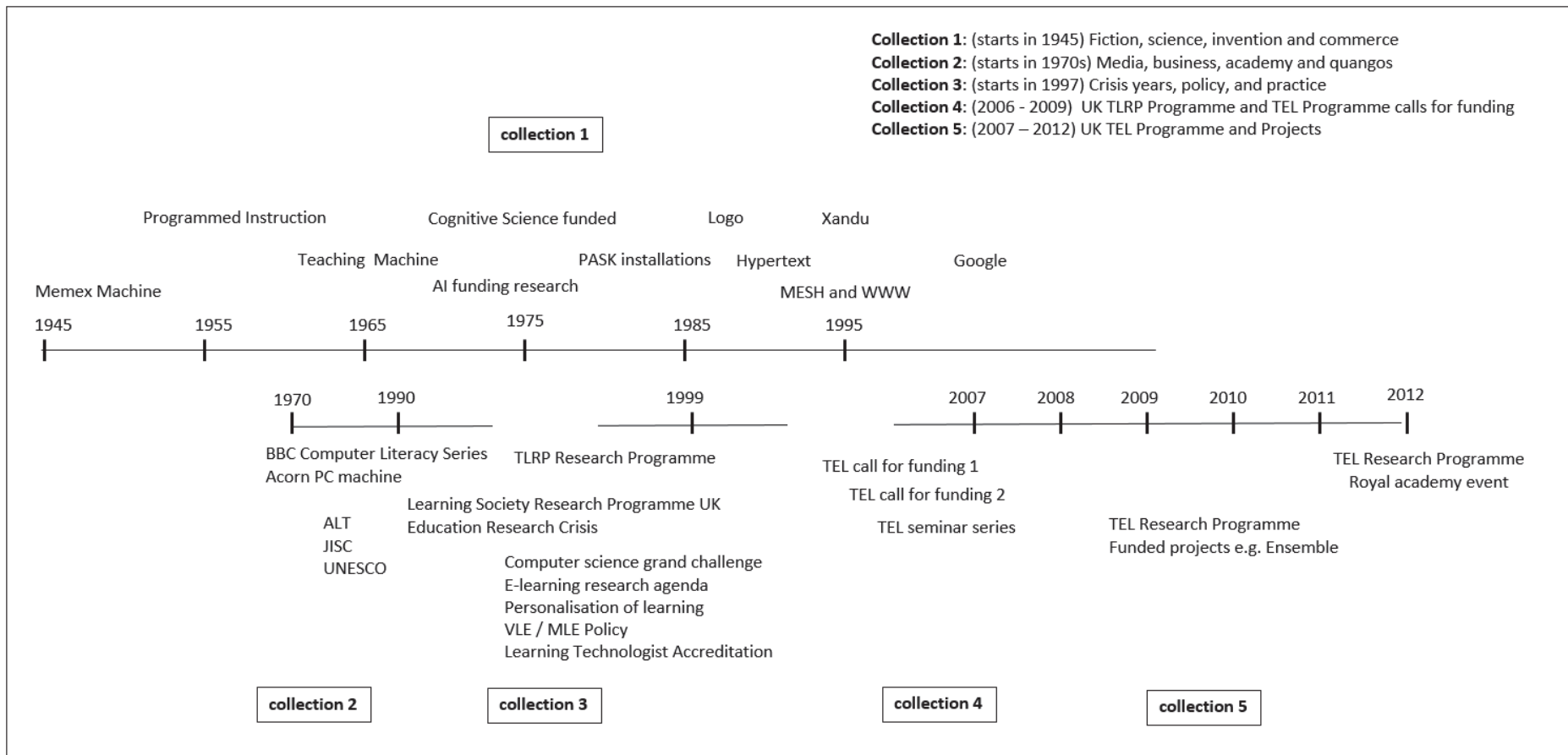
A schematic view of the archive illustrating examples of materials, and the chronological and thematic organisation of the collections.

Figure 3.3   A schematic view of the archive and collections.

Another way into detailed analysis was through more systematic coding in the style of content analysis. As a way of thinking about regularities that connect statements, some discourse analysts (e.g. Phillips & Hardy 2002) recommend focusing on key words, phrases, clusters of ideas, and function and form of images. NVivo supports different kinds of content (audio, video, text and images), and segments of these can be allocated to categories called codes. Codes are keywords that are defined by the researcher and can be developed iteratively as themes and ideas emerge. As new ideas emerged, codes were revised and material revisited many times because, as Rose (2007) writes: "While the Foucauldian framework of discourse analysis is giving you a certain approach to your material it is also crucial that you let the details of your material guide your investigations." (p. 161). In Foucauldian discourse analysis, unlike content analysis, the acts of coding, recoding and counting are not ends in themselves. Instead, these acts are just other forms of immersion and what Foucault calls "eventualization" and the "multiplication of analytical 'saliens'" (1991, p. 76). This involved describing more and more elements, relations and domains of reference until regularities emerged as persistent patterns.

The materials in the archive reference the terms 'technology', 'learning' and 'enhancement' and combine primary data published (discovered on the internet) with secondary data from archives on the internet. The timeline (Figure 3.3) illustrates how I have organised the data (my thesis archive) into the following five collections:

Collection 1: Fiction, science, invention and commerce. This is material that is primarily about *digital technology* but in relation to learning and enhancement. Although the focus is on TEL research in the UK, it made no sense to exclude invention and commerce in the US or the implementation of the first WWW in Europe, which incidentally, connected research communities globally. Many researchers involved in TEL research spent time working in the US, Canada, Europe and Australia. TEL research with a technology focus includes recent developments in fuzzy logic AI in commercial R&D laboratories.

Collection 2: Media, business, academy and quangos. This collection starts in 1970, when personal computers were beginning to be affordable but there was little public demand or awareness of this in mainstream education. The collection includes material from the BBC archives on computer literacy

Collection 3: **Crisis years, policy, and practice.** Collections 2 and 3 are chronological. The material in these collections is about *learning,* but in relation to technology and enhancement. Collection 3 starts in 1997, when digital technology and information and communication services were available as consumer products.

Collection 4: **UK TLRP Programme and TEL Programme calls for funding.** Collection 4 includes material from the time when TEL was first used to describe a field of inquiry that was previously known by other names, including e-learning and educational technology. It includes the TEL call for funding documents (2006, 2007) and material from related publications and seminars from the time.

Collection 5: **UK TEL Programme and Projects.** Collection 5 is materials from the UK TEL Programme and related events and associated publications. My analysis of the material in this collection focused on *enhancement* in relation to learning and technology. The burgeoning of social media and the changes in what counts as research publication and dissemination, means that this collection has extensive mixed-media materials. These include professionally produced glossy brochures, videos published in YouTube, text from twitter streams, and end-of-project reports. The material is original output that was published on the TLRP/TEL website and been downloaded. There is a notice on the original TLRP site giving notice that the site will close in December 2015.

While some aspects of TEL history are clearly chronological (the TEL research programme 2007-2012, would have been a different beast without the ubiquity of personal computers/devices, the internet, and the WWW); the history of TEL as chronological phases is not entirely credible as a history of TEL discourse. The collections overlap but also follow sequentially and in parallel. The description

presented in Chapter 1 of TEL history as a series of interruptions was, I now admit, a necessary simplification to orientate the reader before refocusing on the messy productivity of TEL discourses. This means there is still the conceptual problem of what Law calls honouring mess, and the logistical problem of organising the analysis and the writing.

Latour's (2005) methodology text devotes a whole section to writing about research, what he calls writing risky accounts (Table 3.1. and Appendix B: table 1, 17-22). This is relevant because the particular conceptual resources that I mobilise in this thesis include accounts that are part of the construction of research. Forging the way ahead to present 'findings' involves making decisions about what to include and exclude, and this is also part of the investigation process. Law's (2004) methodology text always works with specific examples in writing about discovery; "I work once again through empirical material – in this case three small case studies" (p. 105). His 'empirical material' and 'cases' are written accounts and inscriptions (e.g. spreadsheets, reports, and memos). A number of discourse analysts note that what brings a discourse analysis to an end is the sense that it is possible to persuasively describe findings by focusing on rich details from a limited selection of material from the larger set that was analysed (Phillips & Hardy 2002; Wetherell et al. 2001; Rose 2007). Foucault's (2002) methodology text is clear that the selection of empirical material should be satisfyingly diverse and include:

> relations between statements (even if the authors is unaware of them, even if the statements do not have the same author; even if the author were unaware of each other's existence); relations between groups of statement thus established (even if these groups do not concern the same, or even adjacent fields; even if they do not possess the same formal level; even if they are not the locus of assignable exchanges); relations between statements and groups of statements and events of a quite different kind (technical, economic, political, social). (p. 30)

These methodology texts indicate precedence for my settling on a small and diverse corpus of materials for writing the empirical chapters (4, 5, and 6). But how do the collections relate to the research questions and the precepts of non-deterministic inquiry? These question are now addressed in the final section in this chapter.

Configuring the inquiry

The practical problems of doing research required me to make decisions that are iterative and messy but nevertheless needed to reach timely closure. Writing about education research, Yates (2004) says: "Not everything counts as research.… [R]esearch is technically 'good' if … it did something very systematically, was 'tight and convincing'; or was impressive in its design; (or) ingenious and creative in method" (p. 16). I take this as permission to construct a creative response to writing Chapters 4, 5, and 6. Mobilising conclusions from earlier in this chapter (based on reading Latour 2005, Foucault 2002 and Law 2004, respectively), these empirical chapters are different responses to the research questions. Each chapter mobilises a different trajectory of non-deterministic inquiry to address the following separate questions:

- Chapter 4: What discourse formations are materialised in the design of digital technologies?
  This data for this chapter is from Collection 1: fiction science, invention and commerce.

- Chapter 5: How are these discourses translated into regimes of truth? What is possible to think and do in the name of TEL research?
  The data for this chapter comes from Collection 1; Collection 2: media, business, academy and quangos; and Collection 3: crisis years, policy, and practice.

- Chapter 6: What non-coherent and coherent discourses of TEL co-exist? and What forms of ordering rendered these productive?
  The data for this chapter is from Collection 5: TEL projects 2007-2013.

Collection 4 is deployed in a different way in Chapters 4, 5 and 6. It includes the 'TEL call for funding document (2006), which was discussed in Chapter 1. The literature review discussed many of the organisations and researchers in the UK that were cited in the TEL call documents. Collection 4 occupies a privileged position in relation to the other collections because it is a familiar part of my personal history as a TEL researcher at the time when TEL research in the UK and Europe seemed to be on the ascent. This is the origin of the research questions: *What is TEL research*? and *Where does it come from?* (see Chapters 1 and 3). Discourse analysis of the TEL call documents features in Chapters 4, 5 and 6. Metaphorically it is designated as a vantage point to describe the discursive constructions of technology, learning and enhancement that constitutes 'fundable' TEL research.

Methodologically, a vantage point is a device that rationalises accounts of 'discourse regularities', 'non-coherence' and 'coherence'. On a critical note, it is true that the vantage point metaphor invokes a physical space where the physical body can stand and scan the physical landscape in all directions. The image suggests an objective location from which the whole landscape is visible. Except of course, the archive is not a physical landscape. Law (2004) reminds us that there are many different ways in which this kind of non-coherence is made coherent, where differences are reconciled so that multiplicity is pushed off the agenda. Research enactment is one such manoeuvre.

Mobilising the idea of a vantage point is a deliberate attempt to acknowledge the performativity of discourse analysis. Some would regard this as a methodological weakness, a failure to find a position outside of discourse. In using non-deterministic inquiry, I subscribe to the view that there is no such generalised 'objective' position (Foucault 1976; Haraway 1991; Latour 2005; Law 2004). This does not exclude the possibility of patterns and regularities that are specific to time, location, materials. That is the work undertaken in the following three empirical chapters.

Chapter Four: Materialising discourse

By definition, a technological project is a fiction, since at the outset it does not exist … there is no distinction between project and object. The two … circulate in the form of paper, plans, departmental memos, speeches, scale models and occasional synopses. Here we are in the realm of signs, language, and texts. In the end … a gulf opens up between the world of signs and the world of things … The observer of technology has to be very careful not to differentiate too hastily between signs and things, between projects and objects, between fiction and reality … A fiction with "variable geometry": is what needs to be invented. (Latour, 1996, 'Aramis or The Love of Technology', pp. 24–25)

Introduction

This chapter is about the discursive construction of '*technology*'. It is about discourse that is stabilised in the design of digital technologies and in human-machine relations. The analysis starts in 1945 (after the Second World War) when digital technology did not exist as material artefacts. From this starting point it is possible to ask questions about the work that has gone into contemporary ascendance of digital technologies and why this is now difficult to reverse, or imagine in any other way. The opening quote captures the rationale for examining discursive relations between "signs and things", "projects and objects" and "fiction and reality" *before* discourse is materialised in machines. In this case the term machine is a shorthand for digital technologies, including hardware, software, information and communication, artefacts and infrastructure.

The discourse history of TEL research describes different forms of materialisation, and how these work and come to endure. Non-deterministic inquiry, as discussed in Chapter 3, involves writing intelligible accounts that are not finite or definitive (Foucault et al. 1991). Therefore accounts of materialisation in this chapter are also about noticing and allowing – not reconciling – things that don't fit. This ongoing ambivalence is taken up in Chapter 6.

The chapter begins by setting the scene, and sets up the scope of the inquiry in relation to the data archive.

This chapter is then organised in five sections. They are:

- *Collection 1: Fiction, science, invention and commerce.* This describes the materials (data) that are analysed, and referenced, in the rest of the chapter.

- *A vantage point: 'technology' in TEL research.* In this section, three regularities are described in discursive constructions of 'technology' in collection 4. These are: the 'factualisation' of technology as closed objects; 'segmentation' of disciplines and fields into domains of knowledge contributing to TEL research; and the 'futuristic' hope and promise (and conversely dread and fear) of technology.

- *Discourse from engineering.* This section demonstrates that the antecedent of TEL technologies can be traced to regularities in the discourse of engineering. Three recurring narratives are explored: first human progress through science; then objectification and essentialist ontology; and ending with how engineers engage in particular forms of reasoning and action.

- *Engineered learning.* The take up of the engineering discourse in TEL research is described as the *engineered learning*. This is examined in four parts that come from how engineers engage in reasoning and action. The parts are: problem framing; de(re)composition; demonstration; and (de)stabilisation. In each part the accounts describes a number of different effects, how they work and how they come to endure.

- *Materialising discourse: a summary.* The chapter ends with a summary of TEL research as materialised discourse.

Setting the scene

In Chapter 3, I explained why historical materials on the internet are a rich data source for exploring the questions *What is TEL research?* and *Where does it come from?* I have organised the TEL research archive into five 'collections'.
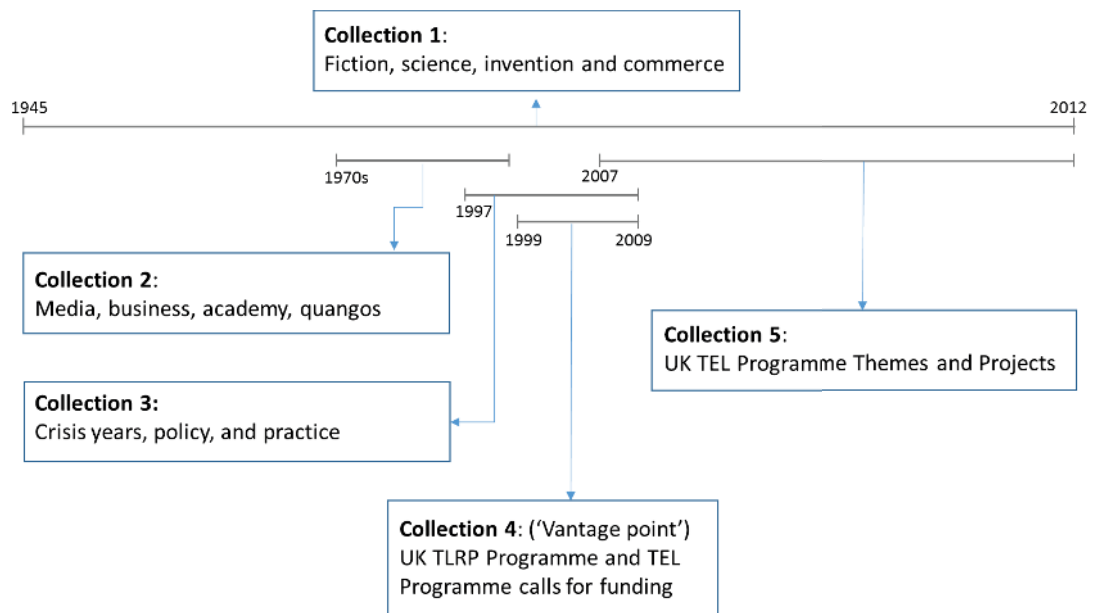
118

A schematic (not to timescale) view of the collections showing the 'vantage point'.   Collection 1 includes materials from 1945 to 2012

Figure 4.1   A schematic view of Collection 1 and the 'vantage point'.

Collection 1 is called 'Fiction science, invention and commerce'. The data in this collection is about the 'technology' in TEL.

In 1945, from which time the earliest materials in collection 1 are dated, there was no such thing as TEL or even digital technology: there were, however, research centres and publications where research into 'the design of technology' and 'theories of human learning and knowledge management' were being regarded as part of the same 'research problem' (Bush 1945; Skinner 1958). My argument is that the historical lineage of discourse from engineering and later computer science and related disciplines, including its continuing relation to commercial developments in mainstream technology research, is an important and mostly overlooked part of the inquiry into *what TEL is and where it comes from*.

Examining materialisation calls for analysis of wide-ranging materials (as data), even if they are not normally studied together or are, in Foucault's (2002) words, "the

locus of assignable exchanges" (p. 30). For example Brooks 1995 classic text *Mythical Man-Month* is about the practices of software engineering. It was hugely influential at IBM (Pugh, 2009) and formative in the design of systems for learning (Martin et al. 2013). In contrast, Suchman, a cultural anthropologist spent 20 years as a researcher at Xerox's Palo Alto Research Center. Her 1987[16] classic text *Plans and Situated Action: The Problem of Human-Machine Communication* problematises rationalised planning approaches to designing digital technologies. Brooks (1995) and Suchman (1987) write about – programmers, software programs, codes, physical devices, knowledge management, software projects, mind as machine, plans and situated action, artificial intelligence, users, design and instructions, accountabilities and simulations. While this is all part of the history of TEL research, these authors and text are rarely cited in TEL research (as demonstrated in the literature review in Chapter 2).

The schematic representation of the five collections in Figure 4.1 is a reminder of how Collection 1 is related to the other collections. Collections 2 to 5 are organised in a chronological sequence. Collection 1 is across the whole period (1945 to 2012) studied in this thesis, and this is because constructions of 'technology' changed with the increasing commercialisation and black boxing of the discourse materialised in the machine. The effects of this on the discourse history of TEL are taken up in chapters 5 and 6.

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[16] Reprinted in the anniversary edition of 2007 this is the text that is referenced in this thesis.

DoB	Person	Identity	Technology	Examples of materials in collection 1
Table 4.1 Examples of materials from collection 1 that are cited in chapter 4				
1890 -1974	Bush, Vannevar	Engineer, inventor, science administrator, Head of U.S. Office of Scientific R&D (OSRD) during WWII	Memex (index, memory, extender) Memex Macromedia animation	(Bush 1945) (Life magazine, November 19, 1945) Images of Memex
1904-1990	Skinner, Burrhus Frederic	Psychologist, behaviourist, social philosopher, and inventor	Teaching machines	(Skinner 1958) Video - Teaching machine
1925-2013	Engelbart, Douglas	Engineer, human computer interaction designer, inventor of the mouse	Augmented intelligence Human computer interaction – the mouse	(Engelbart 1962) The mother of all demos 1968
1928	Papert, Seymour Aubrey	MIT mathematician, computer scientist, educator, pioneer of artificial intelligence	Logo programming language constructivism learning theories	(Papert 1993, 2000) Video Logo demonstration
1922	Supps, Patrick Colonel	Philosopher of science, decision theory, psychology, educational technology	Computer-Assisted-Instruction (CAI)	(Suppes 1966) Demonstration of CAI in maths teaching
1928 -1996	Pask, Gordon	Cybernetics, educational psychology, learning theory, systems theory, conversation theory of learning	SAKI (Self Adaptive Keyboard Instructor)	(Pask 1976) (Haque 2007)
1934	Bitzer, Donald L.	Electrical engineer, computer scientist, inventor	PLATO (Programmed Logic for Automatic Teaching Operations)	(Bitzer 1988)
1937	Nelson, Ted	Pioneer of information technology, philosopher, sociologist	Hypertext Xandu Coined the phrase hypertext and hypermedia in 1963	(Nelson 1965) Video Xandu Demonstration
1938	Sutherland, Ivan	Computer science and internet, graphical user interface, essayist	Human computer interaction – Sketchpad	(Sutherland 1959) Video Sketchpad demonstration
1940	Kay, Alan	Computer scientists, inventor, object orientated programming pioneer	Dynobook	(Kay 1972) Interview
1955	Berners-Lee, Tim	Computer Scientist, Artificial Intelligence, WWW consortium convenor	ENQUIRE (hypertext system World Wide Web)	(Berners-Lee 1996)

Analysing and writing research is about coherence making, and with a sprawling data set it is all too easy to drown in the chaos of detail. My response to this is to assert a vantage point so that the question *'Where does TEL research come from?'* is relative to 'What is TEL?' at that (temporarily) fixed point. In Chapter 3, the UK TEL call for funding documents (2006, 2007) were mobilised as sources (starting points) for tracing relational connections to other materials and this became collection 4 (TLRP/TEL funding calls). The publication of these two documents is taken as a vantage point. The empirical focus in this chapter is on materials from Collection 1 and 4.

The data in this chapter comes from 'Collection 1: Fiction, science, invention and commerce' which spans over 50 years (see Figure 4.1). I call it this because the collection includes different kinds of materials including: fictional accounts of envisioned technology; publications in academic journals; archived multimedia material footage, and demonstrations of new digital inventions, and commercial products.

Material from Collection 1 is used to demonstrate the transformation of discourse regularities from fiction, science, and invention into technology design practices, software engineering and commerce. Some examples of the materials that are referenced in this chapter are listed in Table 4.1. The table is organised to illustrate some of the characteristics that emerged from the analysis. For example, several of the most enduring and persistent accounts (in relation to technology, learning and enhancement) were found to be associated with celebrity researchers, their research groups and students. There is evidence of generational alliances and conflicts, and this is signalled in the years of births and deaths of these prominent researchers. Another observation about the data was the fluid movement of researchers across boundaries of social science, computer science and education. This pattern is recorded in Table 4.1 as 'identity' of the key figures. While the boundaries were not disciplinary there were stabilisations of particular approaches that led to a kind of dynasty of disciples, theories of learning design, technologies and systems. This boundary making is used in the organisation of example materials in Table 4.1. A key point is that the wide variety of materials were analysed, included:

- three generations of scientists, researchers and inventors, and their institutional and other affiliations;

- technology prototypes, experiments, and commercial R&D research;

- examples of conflict, which is played out as adversarial scientific, intellectual, and political controversy; points of diffraction when things appear incompatible: and different discourses that are then characterised as points of equivalence

- examples of publications and interviews with people who locate themselves in different fields (e.g. Cognitive Psychology, Human Computer Interaction Design, and Artificial Intelligence).

A vantage point: 'technology' in TEL research

This section is about what is *'technology'* in TEL research from the vantage point of the UK TEL call for funding documents (2006, 2007). These are analysed as a temporary stable discourse of TEL research suggesting three discursive regularities in how 'technology' is constructed in TEL research.

The first regularity is '*factualisation*' of technology (in TEL research). Factualisation is an invented term that combines the descriptive sense of 'factual' as 'objective truths', with the verb stem that indicates that 'work' is involved in the making of 'facts'. The factualisation of digital technology works by presenting a list of assertions about TEL technology as more or less mature, reliable and established. Both the TEL call documents (2006, 2007), inform the reader that "Technology is now a common aspect of learning and everyday life" (p. 3). Statements about technology, are offered in the same factual terms as statements based on audit questionnaires which report that 68% of 15-year-olds use computers for school work; and in Higher Education 9 in 10 institutions report delivering teaching materials online. The differences between these claims are smoothed over and the effect is to suggest a gathering mass of evidence that technology is embraced, established and stable. What follows is statements like this:

> "the research Call takes place against a background of significant developments in advanced ICT techniques They are establishing an <u>advanced</u>

e-infrastructure that includes the virtualisation of computational and data resources through the techniques of *Grid computing*, the automated processing, ….., and new mobile and ubiquitous computing systems." (ibid. p. 4, underlines added)

The underlined technologies are at different levels of generality, and maturity, and concerned with quite different domains and technologies, yet they are all active in the same set of statements as matters of fact. 'Facts' are asserted and then legitimised by reference to consultation reports written by groups of experts commissioned by governmental funding bodies (Taylor et al. 2004). The TEL call documents reference *only* the work of collectives, organisations and institutions. In effect, consultation meant that committees of experts were convened to translate research debates from computer science and other research communities, into funding priorities authorised by governmental policy (*Harnessing technology Transforming Learning and Children's Services* 2005).

Actor-network theory uses the term 'punctualisation' to describe processes whereby separate networks (whole other worlds) are converted into a single point or node. In the TEL call document, punctualisation works by combining assertions that are positioned as facts about technology, with claims that all the relevant communities have been consulted and the TEL call documents (2006, 2007), now speaks for them all. TEL researchers, bidding for TEL funding, were invited to conceptualise technology in TEL research as a matter of utilisation, configuration and exploitation. In this way the regularity that punctualised 'the technical' in TEL research renders invisible the discourse(s) materialised in the design of technology.

The second regularity is the 'segmentation' of TEL research. The term 'segmentation' not only describes the tendency to conceptualise knowledge production as an essential properties of disciplines and fields, but also signals that work is involved in creating boundaries that divide and differentiate domains of TEL research. The title of 'e-learning research' is used in documents referenced in the TEL Call, but in the text of the TEL call 'e-learning' no longer fits and instead 'technology' and 'learning' are separated as historically segregated areas of research.

This is evident in the insistence that researchers demonstrate capacity for authentic interdisciplinary collaborations:

> "Collaboration across disciplines in the academic community indicates a willingness to understand the bigger picture in pursuit of innovative, creative and exciting solutions…" (ibid. p. 4)

The 'solution' is with reference to the 'problem' of what TEL research should be doing. Discursively the effect of this is to reduce the complex boundaries between domains of knowledge into a binary power struggle. On the one hand, 'technology' is presented as complete and powerful, and 'learning' as in need of intervention. On the other hand, the possibilities for TEL contributing to 'technology research' are confined to reconfiguring and adapting existing technologies for learning. Technology is constructed as a tool or service with no particular agency independent of human intentions. This second regularity raises questions about the discourse history of 'technology' and 'learning', how these are discursively separated, and what then is materialised in the design of digital technologies.

The third regularity can be described as 'fantasmatic'. The fantasy of the future works to persuade, enroll, seduce and otherwise grip the subjects, that is, the researchers, funders and others invested in TEL research. Fantasy in this sense is a *vision* which is narrated as some persuasive imagined futures, and the *promise* that technology can deliver this. In the TEL call documents the four themes 'personalisation', 'productivity', 'inclusion' and 'flexibility' look to the future, and the narrative works by incorporating references to features of digital technology to describe an idealised fullness for human learning:

> "Personalisation: Transforming the quality of learning, teaching and assessment by exploiting the responsive and adaptive capabilities of advanced digital technologies to achieve a better match with learners' needs, dispositions and identities." (ibid, p.10)

This statements suggest a social reform narrative that is self-legitimating in invoking fear and dread of the opposite, indeed there is no case to be made for the opposite themes '(de)personalisation', '(un)productive', '(ex)clusion' and '(in)flexibility'; it is

unthinkable. The fantasmatic is also about the 'work' involved in smoothing over the contradictory values and conflicting research agendas, and this is taken up in Chapters 5 and 6.

Discourse regularities described as 'factualisation', 'segmentation', and 'fantasmatic' have a discourse history. Using vocabulary from actor-network theory, the effect of these regularities is to stabilise designed object in which technology is black boxed in digital artefacts, application software and services. Taken together these black boxes are metaphorically the *technology and the machine*. In effect, the discourse that is materialised is rendered invisible. The rest of this chapter is about the discourse history of this materialisation and the constructions of 'technology' in TEL research.

Discourse from engineering

In 1935 the US Navy asked Vannevar Bush for advice on designing machines to decipher increasingly sophisticated Japanese communications codes (Burke 1994). This led to research and development contracts, major investment in building, and a superfast machine to count coincidences of letters in encrypted messages.

> In 1942, the ROCKEFELLER DIFFERENTIAL ANALYZER (sic.) was dedicated to winning the war…this large mathematical machine, the centrepiece of MIT's Center of Analysis labored over calculations of firing tables and the profiles of radar antennas…Wartime security prohibited its public announcement until 1945, when it was hailed ….as a great electromagnetic brain ready to tackle the problems of peace…(Owen 1991, p.4)

In other words, this was the advent of information processing on a scale not possible by humans alone. Owen (ibid.) notes that following MIT's lead, Differential Analyser machines were built in England (Manchester and Cambridge), and in Ireland, Germany, Norway, and Russia. This history of computing after the Second World War suggests that it is impossible to think of computers separately from large and expensive hosting facilities, an army of engineers, skilled technicians to maintain the machinery, and trained operators to run programs. All of this amounted to some

lengthy research projects and major investments (*Mark 1 the Baby* 2008; *BBC video of Tony Sale talking about the Colossus* 2010). The material mass of the early computers needed engineering facilities with reinforced concrete floors and high ceilings (e.g. The Virtual Museum of Manchester Computing[17]).

This is interesting because TEL research and its history is not usually associated with the discourse of engineering, nor is there any obvious connection from the vantage point of the TEL call for funding documents (2006, 2007). Nevertheless, this significant lineage is evident in Collection 1. Many of the early researchers, scientists and academics who were the pioneers of what became TEL research, were trained in engineering faculties, some examples are: Bush, Kay, Skinner, Englebart, Papert, Supps, and Pask, who are represented in Collection 1 (see Table 4.1). Discursive associations between engineering knowledge and knowledge about human performance are the effects of connections between networks of engineers and social scientists. In this way researchers and research groups are *translation nodes*. For example research on models of electro-mechanical engineering at MIT was developed into a theory of neurons (Hayles 1999): "the MIT model of human neuronal circuits constructed the human in terms of machine, and later articulated it more thoroughly in terms of computer switching" (Barnet 2008, p. 44). Historical relations between digital technology innovations and engineering is evident in the naming of a profession as 'software engineering' (Naur & Randell 1968). These partial connections are arguments for examining the discourse of engineering as a way into understanding contemporary TEL research and its discourse history.

The focus of this discourse analysis, in this section, is on the much cited article *As we may think* by Vannevar Bush and the accompanying editorial in *The Atlantic* (1945). *The Atlantic* magazine at the time had a wide readership of scientists, educators and intellectuals, and the article is interesting in celebrating 'engineering science' as a field. Bush's article is a useful place to start because it is an early example of discourse from engineering being deployed to describe human machine interaction, information processing and "the store of human knowledge" (Bush 1945, p. 1). Having described the links between TEL research and engineering practices,

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[17] http://archives.icom.museum/vlmp/computing.html viewed 28 November 2015

this raised two questions. First, how is the discourse of engineering authorised and legitimated? Then second, what are the forms and elements of the discourse of engineering?

In order to respond to the first question, if there is a discourse of engineering, as I assert, then there are institutions within which the discourse is produced and circulates, and which produces subject positions, including those who are authorised to speak and be heard (spokespersons). The editor's introduction to *As we may Think* (Bush 1945) is informative in this respect:

The Editor asserts Vannevar Bush right to speak for American scientists and engineering. His credentials to speak and be heard are asserted with reference to leading 'six thousand scientists' in the 'successful' activity of 'application of science to warfare'. The professional subject (scientist engineer) is connected to the success of the war efforts in the application of science to warfare, and a legitimate representative of discourse that is produced and circulates within governmental institutions, including the secret service and the military. This then is the *spokesperson*, the scientist engineer who is authorised to speak on research topics to do with science, engineering, invention, and the future. The spokesperson speaks for the group referred to as scientists and engineers. Notably this goes further in connecting to a closely related set of science traditions (positivism and empiricism) that argue that scientific truths are logical relations or laws that describe the world and, by implication, how to control it. Science narratives authorise the expansion of engineering research beyond the engineering of machines, to the engineering of humans, knowledge and human-machine systems.

One effect of this discourse is to expand the scope of research that is legitimised as 'engineering science'. There is work involved in framing what is possible to think of as engineering science, and this is illustrated by three science narratives in the text of *As we may think* (ibid.):

- *The narrative of progress* claims the success of engineering in augmenting "man's physical powers" as a scientific achievement. The 'progress' argument is constructed as self-evident results of modern science in that artefacts are said to

be invented by applying the methods of modern science. This is constructed as progress because, the strong claim is that designed artefacts can enhance human capabilities, both physical as in the example of the hammer and microscope, and intellectual as implied by connecting the 'machine' to 'thinking'. Discursively 'progress' is tied to the achievement of science and engineering.

- **The narrative of objectification** works by constructing research as a study of external reality that is independent of human interpretation (a view from nowhere), and then by naming research objects which are asserted as part of this external reality. In other words, as facts about the world. For example, in combining the reference to "instruments' (invoking previous engineering successes) and "knowledge of the ages", the latter is produced as an new object of research.

- **The narrative of essentialism** asserts that things have an essential nature (i.e. essence), and that research into concepts and objects is about finding the truth within things. Once a 'thing' (e.g. technology, human intellect) has been objectified, the narrative of essentialism takes hold so that linguistic metaphors like 'storing knowledge' and the 'wired brain' translate into essences, or the essential truths about things. In general, the narratives of objectification and essentialism connect the positivist science ontology of progress through science with the invention of material artefacts as evidence of progress. The discourse opens the possibility of producing a new technological object of TEL research, namely, the invention of appropriate tools to make possible new relations between "thinking man (sic.)" and "sum of knowledge" (ibid. 1).

This discourse of engineering is both a systematic body of knowledge and an exercise of power that validates research practices in particular ways. But then what are the forms and elements of this discourse of engineering? How does it *work?* As discussed in Chapter 3, Foucault describes *regularities* as patterns that describe how discourse *works*. I use the term as a shorthand for referring to patterns in relations between the forms and elements of discourse, in other words how it *works*.

The early TEL researchers shared a hinterland of engineering. Based on analysis of text from collection 1 (e.g. Bush 1994) and studies of engineering discourse in the

literature (Johnston et al. 1996; Latour 1996; Perelman 1999) I identified   the presence of at least four regularities in the discourse of engineering: (1) Problem framing; (2) De(re)composition; (3) Demonstration; and (4) (De)Stabilisation. I will describe these briefly now.   In the next part of this chapter I show that these regularities are part of the discourse history of 'technology' in TEL research.

Problem framing is about persuasive argumentation. In engineering this involves asserting what counts as the problem and the solution, thereby making it possible to claim a progressive history of solving some problem to bring about some improvement. The authority to encapsulate holds for different scales of 'problems', from the very large, as in sorting out the problem of human knowledge, to the more specific, for example designing a filing systems to store and access files. Problem framing works by simplifying complexity, contingency and the unknown into 'fact like' statements which rely on the narratives of progress, objectification, and essentialism.

De(re)composition is about purification by *reduction*. This works by first, decomposing 'the problem' into smaller parts. The parts are then reframed as components of the problem. Each component is interpreted as performing function(s) which need to be improved and in engineering terms optimised in some quantifiable way. Bush writes:

> "Machines with interchangeable parts can now be constructed with great economy of effort. In spite of much complexity, they perform reliably…..and ….Witness the humble typewriter, or the movie camera, or the automobile. Electrical contacts have ceased to stick when thoroughly understood." (Bush 1945/1995, p 113)

De(re)composition reduces complexity and makes it possible to work on separate parts that can be recomposed to engineer reliable and predictable performance. The discourse of engineering works by abstraction in which complex (and messy) details are concatenated, reduced, simplified or excluded, and all of these activities rely on the narrative of essentialism.

***Demonstration* is about *showing it works*.** In engineering research, prototypes are deliverables that show that the components parts do what is claimed they can do. When engineers talk about *work* they mean "work in the sense of machines, software, algorithms, and things that are concrete" (Van Dam 1999, p.15 interview quoted in Barnet 2010). The demonstration is an important construct in engineering discourse, with equal status alongside design drawings and textual accounts. The working demonstration generates its own milieu in use teaching those who use it about the possibilities it contains and its materially technical limits (Barnet, 2008). The final product is an assemblage of many components and is therefore made up of many black boxes as in Bush's example of the typewriter, camera, and car.

***(De)Stabilisation* is about *closing the black box*.** This is a stabilisation in which problem framing, de(re)composition, and demonstration activity are successful so that a set of design choices is stabalised. The design is materialised into component artefacts which perform set tasks to a known consistent standard. In engineering stabilisation is achieved by modularisation of components into separate black boxes, which makes it possible to mass produce reliable interchangeable parts. The typewriter, camera, car and electricity are given as examples of solving complex engineering problems in this way. Engineering solutions are regarded as successful if they are reliable, cost effective, and efficient, and taken up by the public as consumer goods and services. The implication is that engineering research is successful when artefacts developed in engineering laboratories are taken up by commerce and developed into commodities and services that are profitable, and desired by a large constituency of customer / users.

This section has described the discourse of engineering and the "widespread faith in biological-mechanical analogues at the time as models to boost human functions" (Barnet 2008, p. 46); governmental military interest in technology to replace human faculties (De Landa 1994, p. 127); and "the image of the machine as the basis for the understanding of man" (Hatt 1968, p. 28). The remaining analysis in this chapter is about how discourse regularities from engineering are translated. This is part of the discourse history TEL research.

Engineered learning

Returning to my research question *What is TEL research?* and *Where does it come from?* so far in this chapter I have come to some conclusions about constructions of 'technology' in TEL research. From the vantage point of the TEL call documents, I described three regularities: the *factualisation* of 'technology' that hides the socio-material history of design decisions; the *segmentation* of TEL research into cognitive science, computer science and education studies as uncontested perspectives on the same TEL problems; and the *fantasmatic* expectations of technology to deliver personalisation, productivity, inclusion and flexibility. If this is 'technology' in TEL research (form the vantage point) then *Where does [this] TEL research come from*? That rest of this chapter addresses that question.

In this chapter it has been noted that early TEL researcher were engineers, and that early TEL research was located in engineering facilities. Clearly TEL research has a discourse history that is related to the discourse of engineering. These observations prompted an analysis of discursive *regularities* in engineering practices. That analysis characterised how the discourse of engineering works through the four regularities of: problem framing, de(re)composition, demonstration; and (de)stabilisation.

To understand how regularities from engineering have shaped and changed the constructions of 'technology' in TEL research, the rest of this chapter uses the textual device of writing accounts. Accounts in this sense are discursive vignettes, they are a research construct that mobilises data to present a segment of analysis. The accounts that follow describe how the post-war engineering discourse is part of the discourse history of *Where TEL comes from?* Each account describes a discursive shift that has come to shape *What TEL research is*. The accounts are organised as follows:

- Problem framing and two accounts: (1) Turning facts into assertions; and (2) Deliberating on 'doing good'.

- De(re)composition and three accounts: (1) Logical de(re)composition; (2) Iterative de(re)composition; and (3) Abstraction as re-composition.

- Demonstration and three accounts: (1) Research by demonstration; (2) Demonstration as proof of concept; and (3) Demonstration as a means of collaboration and exploration.

- (De)stabilisation and three accounts: (1) Stabilisation as a discourse that materialises technology; (2) (De)Stabilisation as socio-material relations; (3) and Stabilisation as algorithms.

These accounts can be understood as part of the discourse history of *Where TEL comes from*, and that continue to shaped the limits of what is possible to think and do and counts as TEL research, technology design, and learning.

Problem framing

Earlier in this chapter, I described problem framing as argumentation that engineers use to persuade their peers and sponsors that there is a problem that needs solving. This is as part of engineering discourse. But what changes when both *technology* and *learning* are constructed as part of the same discourse? In other words, what are the discursive shifts when technology design, knowledge production (i.e. research) and what it means to enhance learning connect and change one another? As an example of this, consider this text from Collection 1:

> Our ineptitude in getting at the record is largely caused by the artificiality of systems of indexing. When data of any sort are placed in storage, they are filed alphabetically or numerically...… The human mind does not work that way. It operates by association. With one item in its grasp, it snaps instantly to the next that is suggested by the association of thoughts, in accordance with some intricate web of trails carried by the cells of the brain. (Bush 1945, p. 6)

The statement describes a problem with retrieving records that are stored by indexing. This problem is then generalised as one of information processing. Following this the statement asserts that the human mind and brain is an information processing system that works like a web of trails. This shows that that *Where TEL research comes from* has a discourse history in which both 'technology' and the 'human mind' are constructed as objective truths in the same way on the bases of the

same rules (Foucault 2002). The rules are persuasive regularities which work by: (1) turns assertions into 'facts'; and (2) deliberating on 'doing good'. Both of these are discussed in the accounts that follow.

Turning assertions into 'facts'. How do assertions about problem framing become 'fact like'? At the turn of the present century research into human intellectual life, including studies of 'teaching and learning', relied on introspection (Glymour 1997; Stich 1985). As Suchman (2007) puts it, introspection was not amiable to the (then) emerging canons of scientific method and so was inherently unscientific. In 1958, Harvard psychologist Skinner published his work on applied behaviorism in a paper with the title Teaching machines, which had the strap line: "From the experimental study of learning come devices which arrange optimal conditions for self-instruction." (p. 969). He proposed to confine the notion of 'learning' to what could be observed. Chomsky and his colleagues made their name in opposition to Skinner's behaviorism (Chomsky 1967). They took the position that the study of cognition could be more scientific and empirical (this is explained shortly). In both cases, assertions about the separateness of the mind, it's physical location in the brain, and learning as essentially a form of cognition are taken as truths. Discourse becomes invisible when "facts are usually presented without trace of their origins and without any subordination to doubt, surprise, or even acceptance" (Sismondo 2010, p. 149).

The separation of mind and body and acceptance of human cognition as an objective truth, opens the possibility researching learning, intelligence and pedagogy as objects of engineering. There is a discursive shift in what counts as knowledge or '*knowing*'. In other words, '*knowing*' which is embodied in organic material of the human body is set up *as* equivalent to '*knowing*' that is engineered mechanically in nonorganic matter. In effect the study of human intellectual life is aligned to study of computers while retaining the commitment to scientific inquiry and engineering human progress (Suchman, 2007). The phrase 'artificial intelligence' (AI) was first used in 1955 to describe the study of intelligence by encoding features of intelligence into a computer program (McCarthy et al. 1955).

During the 1960s and 1970s researchers in AI and affiliated fields like Human Computer Interaction Design were physically co-located with researchers who studied intelligence and learning (Denenberg 1978; Kay 1972; Suppes 1966). Chomsky and others worked on what became cognitive science, a field concerned with mental representations and rules that underlie perceptual and cognitive processes. Critically their work shared a vocabulary with the emerging field of computing; indeed Boden (2006) is more definite: "Cognitive science is the interdisciplinary study of mind, informed by theoretical concepts drawn from computer science and control theory" (p. 12). Networks of researchers shared fringe meetings, counter-culture rhetoric and the conviction "that cognition is not just *like* computing; it literally *is* computing" (Suchman 2007, p. 37 italics in the original). Cognitive science stabilised by attracting research funding, forming academic departments and research groups, and when the was incorporated in 1979, the organising committee included "scholars from psychology, linguistics, computer science, and philosophy" (Cognitive Science Society website[18]).

This discourse history is relevant because problem framing from the engineering discourse has been translated from mind/machine analogies, to 'facts' about the field of human cognition – what it is and how it can be studied. The construction of human-technology *equivalence* can be traced forwards into the treatment of 'technology', 'learning' and 'enhancement' as objects of engineering and this is discussed in the section on de(re)composition.

I now want to suggest that this discursive shifts works because of the energies invested in moralist persuasion. The discourse history of TEL research is interesting in that all the researchers and research groups deliberate on 'doing good'.

Deliberating on 'doing good'. The deliberations on 'doing good' can be traced to post-war engineering discourse of building a better world. This discourse of 'doing good' is fantasmatic in its talk of human progress, happiness, inclusion and social justice. The idea of 'good' is widely recognised as a subject of political debate "the preservation of existing good things, or the acquisition of goods that we do not

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[18] http://cognitivesciencesociety.org/about_overview.html viewed 29 November 2015

possess, or the rejection of existing evils, or the prevention of harmful things expected to occur" (Aristotle 1954, p. 279). However, this recognition of relative values is masked because problem framing works by equating particular 'goods' with scientific reasoning and progress. The fantasmatic rhetoric as a form of persuasion is evident in statements from a range of materials in Collection 1. Here are three examples:

More effective learning: "THERE ARE MORE people in the world than ever before, and a far greater part of them want an education. The demand cannot be met simply by building more schools and training more teachers. Education must become more efficient." (Skinner 1958, p.158)

Leaner centered pedagogy: "Paraphrased: A key to understanding why School is what it is lies in recognizing a systematic tendency to deform ideas in specific ways in order to make them fit into a pedagogical framework…The answer drawing on developmental psychology (Jean Piaget) is learning by discovery and experimentation. …." (Papert 1993, 2000)

Personalised learning. "The single most powerful argument for computer-assisted instruction is an old one in education. It concerns the advantages, partly demonstrated and partly conjectured, of individualized instruction". (Supps 1960, p.206)

Even when they are advisories and bitterly critical of each other's research, researchers set their sight on claiming the greater good for the learning subjects. Sometimes the rhetoric is economic, as in Skinner's (1958) argument that there are more people in the world and they all want an education, and so his question is what labour-saving capital equipment can deliver larger quantities of education more effectively

Bricolage of images from publications in Collection 1. These are different traditions in the history of TEL research that all share the discourse of deliberating on 'doing good'

Figure 4.2   Bricolage of Images from Collection 1.

On the surface, Skinner's deliberation is very different from Papert's (1993) manifesto like statement that schools deform ideas. In peer reviewed articles, Papert often starts his deliberations with an emotional story for example:

> Last fall I worked almost daily with a small group of deeply troubled teenagers … As I got to know Michael better I came to understand that seeing an idea where others saw an instrument of violence was characteristic of his mind. (2000, p. 720)

Papert wants to persuade us that the School mind-set has a bias against ideas in favour of skills and facts, and that the design of computers as mediators between ideas and learners is the desirable design challenge. Suppes (1966) argues for the greater 'good' of individualised instructions with computer-assisted pedagogy. Other researchers claim more 'goods'. Nelson (1965) advocates the greater 'good' of freedom from the straight jacket of linear text in his *A File Structure for the Complex, the Changing , and the Indeterminate* (Nelson, 1965). Pask (1976) is less obvious in his claims to 'good' but his focus on the dialogue has been taken up in contemporary representations of "What does it take to learn" (Laurillard 2008).

I propose that the themes in the TEL Call, that is the fantasmatic vision and promise of personalisation, productivity, inclusion and flexibility, are not so new. This is most clearly demonstrated in images associated with text from quite different TEL traditions (Figure 4.2). These are the images of personalised technology and the engaged learner; images invoking productivity because the teacher has tools /assistance in teaching large classes; and images of a variety of learners (male, female, different ages, ethnicity and at different stages of development). These images speak to the counter-cultural aspiration of inclusion and social justice. Flexibility is depicted in idyllic images and stories of self-directed learning which is effortlessly like play. Statements and images in materials from Collection 1 illustrate how deliberations on 'doing good' works to persuade, win over, seduce, and in other ways convince the audience that the envisioned human-technology configuration is desirable for individuals and for human progress in general.

This section has illustrated that problem framing in engineering science can be interpreted with reference to the multiple narratives of objectification, essentialism and progress. In exploring how this discourse is translated in TEL research (represented in Collection 1), attention was drawn to the combined effect of objectifying 'mind/intelligence' and 'technology' as separate objects, and then classing these objects as equivalents and equally disembodied. In the process, metaphors and assertions are translated into 'facts' about human cognition and learning. In addition, human-technology relations from research practices in engineering, cognitive science and related fields discursively construct fantasmatic visions and promises that stand for truth and 'good'.

The discursive effects of particular forms of problem framing are powerful in channelling what is possible to think, imagine and do in engineering digital technology, in other words, what is materialised in design details. This is described in engineering discourse as de(re)composition.
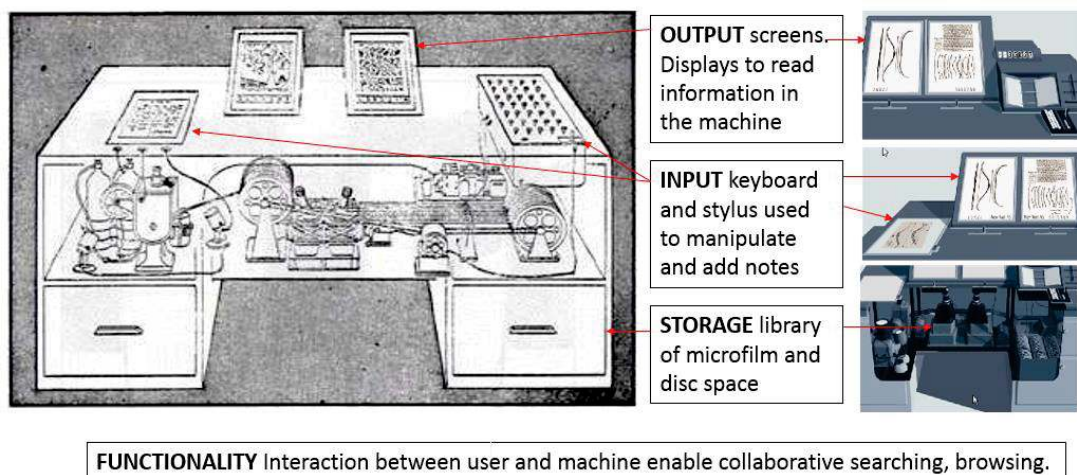
Worked example of de(re)composition. The requirements decompose human performance 'problem, the parts are then mapped to components and functionality of the machine. In the diagram the machine are the Memex Desk (Bush 1945), and the Macromedia demonstration (2003)

Figure 4.3   Memex Desk -worked example of de(re)composition.

De(re)composition

Earlier in this chapter, decomposing was described as an engineering construct in which the problem is analytically broken down into smaller parts. Each part of the problem is solved by component(s) that address only that part of the problem. Decomposition as a way of doing design is, of course, not given in the order of things. Never-the-less decomposition practices from engineering have been taken up by software engineers (Jalote 2008; Okoli & Schabram 2009; Brooks 1995; Sommerville 2010). The design of technologies for learning by software engineers means that different enactments of decomposition is part of the discourse history of *Where TEL research comes from.* In this section I describe three different accounts of decomposition : (1) logical de(re)composition; (2) iterative de(re)composition; and (3) abstraction as re-composition. In each case I end by describing its effect on conceptions of '*what TEL research is'.*

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Logical de(re)composition. How is de(re)composition enacted though logical analysis? How do we know this has happened? The article *As we may think* will be familiar to the reader from earlier analysis and so I use the same text to illustrate logical analyses. Figure 4.3 shows Bush's Memex illustrated in *Life Magazine* in 1945 (reprint Bush 1995). The Memex is a portmanteau of 'memory' and 'index' and was envisioned as a memory extender. The machine is imagined as a desk-bound, physical hypermedia system (Figure 4.3). Some 50 years later the functionality of the Memex machine was animated with multimedia software called Macromedia (Macromedia[19] 2003). In the Macromedia version, the analogue components from the desk have are replaced by digital devices. This is shown on the right in figure 4.3.

These materialisations (Bush's Memex, and the Macromedia demonstration) are examples of logical de(re)composition. The problem is first framed as a limitation of human cognition, meaning that people find it difficult to process large volumes of 'knowledge' stored in print and other media (Bush, 1945). This 'human limitations' problem is logically decomposed into parts. The parts of the problem, in this case, include read, record, store, retrieve, search, browse, annotate connections and so forth. These parts are then interpreted as technical *requirements* for separate device components. Therefore, there are device components for output, input, and storage, and processing routines for searching, browsing and annotating. The list of components and functions are shown in figure 4.3.

Decomposition logic is about divisions of knowledge and expertise. This has been the case in the reported history of software engineering (Wirth 2008). For example, decomposition of a TEL technology design problem can be characterised (in simple terms) as:

- World view: Requirements for teaching and learning

- Abstract view: Problem definition, data structures, process

- Implementation View: Program, variables, instructions

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[19] The diagram shows screen shots from a recording of a Macromedia Director application that was built to commemorate the 50th anniversary of Bush's 1945 "As we may think" paper. The application was built by Dynamic Diagrams and was distributed at the ACM SIGIR conference in 1995. It was uploaded to You Tube Nov 18 2009 (accessed 8 Jan 2015) and is archived in collection 1.

The relations between the layers are designed, that is, they are constructs rather than 'facts', although once they are materialised the functionality of the software is rendered factual.

Logical decomposition is an essentialist systems discourse. TEL technology is separated into a work flow system that moves in a linear way through set stages of the project. The effect of logical decomposition is that it becomes possible to separate TEL research from software implementation in terms when it happens (time), where implementation takes place (location) and who does it (expertise).

Iterative de(re)composition. Iterative decomposition works in a different way to logical decomposition. Instead of separations there is a folding of boundaries because research into 'pedagogy and learning' runs in parallel with 'design and implementation' of TEL technology. An example of this is the development of the programming language called LOGO (Papert 2000). LOGO is described in the MicroWorlds user guide (Papert & Silverman 1997) as a 'technology' and a 'pedagogy of construction'. Papert (2000) writes: "It is close to 40 years since I fell in love with the idea that a technologically rich environment could give to children who love ideas access to learning-rich idea work" (ibid., p. 721).

An effect of iterative de(re)composition is that the curriculum is reimaged as an iterative spiral in which 'learning' is decomposed and the same ideas are revisited at different levels of complexity. Papert (1993, 2000), for example, draws on Piaget's analysis of learning stages to describe the teaching of probabilities. He asks us to "imagine a scenario in which a child grows up from an early age using computers that lead to a high degree of technological fluency" (ibid., p.726), and he goes on to decompose the pedagogy and technology for teaching probabilities to different-age children:

- Age five probabilities are experienced by manipulating software with sliders and playing games that simulate probable outcomes of actions in the virtual space.

- The next stage builds on this experience so the technology is like a physical toy that can be programmed using LOGO can be manipulated by reasoning about probable action.

- The same technology can be reprogrammed so the learner can analyse and test particular probability problems like the probability of birthday coincidences in a class.

Iterative decomposition allows digital construction and simulation, what Papert (2000) called constructionism. This is in other words learning iteratively by building and doing. Constructionism is supported by TEL researchers who typically develop software as well as write about pedagogy and learning (Dahaene 1997; Sutherland 1984) and is part of the discourse history of *Where TEL comes from*.

Abstraction as re-composition. The idea of 'representation', 'abstraction', 'heterogeneous entities' and 'scaling up' come from computer science and software engineering. These design constructs are familiar to some researchers perhaps impenetrable to others (including TEL researchers). Yet abstraction, in particular, is the holy grail of software design. I include this section by way of opening this black box.

Nobody would dispute the important of the World Wide Web (WWW) as a TEL technology, but Tim Berners-Lee's original 1989 proposal to implement the WWW was not associated with TEL research at the time. The original version, found buried deep in the archives of the WWW3 consortium website, was in fact a modest request for funding, to solve an information sharing problem, which is described as local to 'The European Organisation for Nuclear Research', namely CERN and LHE[20]. The funding was to produce a working application in three months, and the application was described as a MESH. Tim Berners-Lee specified the system and introduced the term 'World Wide Web' (WWW) when writing the code (1989, 1997, 2000). He did not use the terms 'learning', 'learn' or 'enhancement'. Nevertheless, the design, described as a potential candidate for the MESH/WWW system, was one for recording the knowledge, skills, and experience associated with CERN researchers, and tracking their professional development over time.

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[20] *Large Hadron Collider* (*LHC*) is the world's largest and most powerful particle accelerator. This is the apparatus that made popular news in 2012 in relation to Higgs boson 'God particle. (CBN news Science and Technology, March 15, 2013)
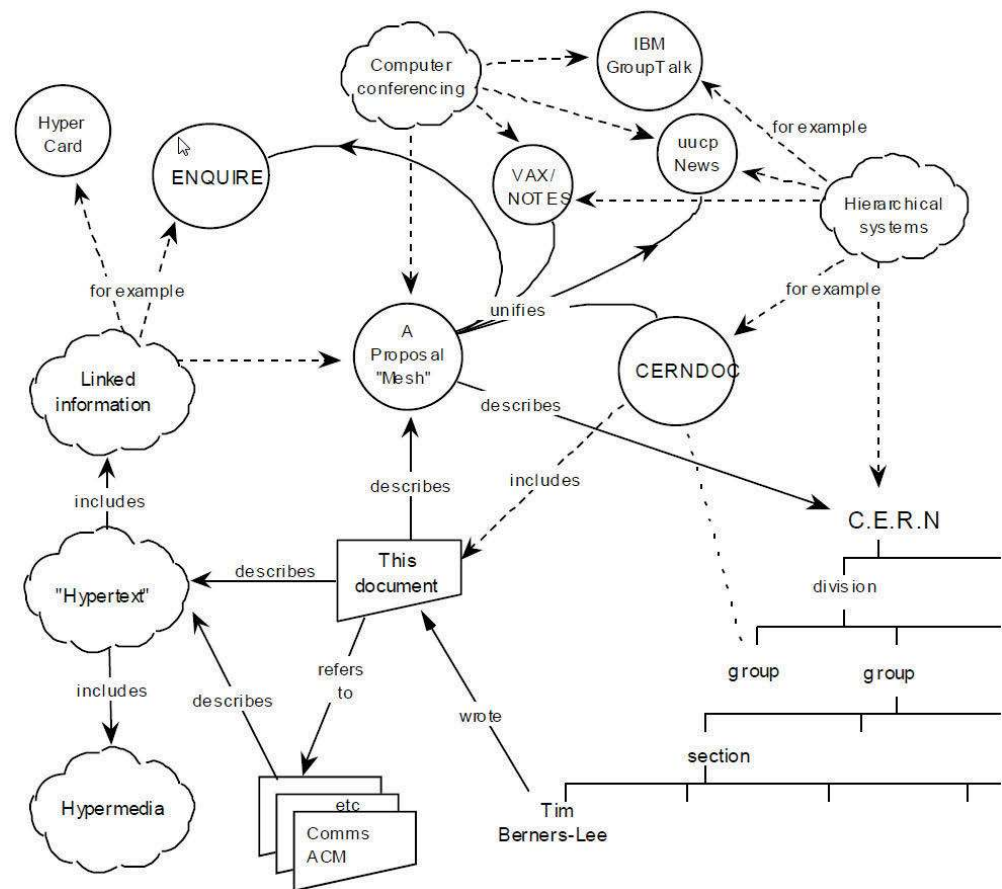
Figure 4.4 The circles and arrows, nodes and links have different significance in various sorts of software design diagrams. It is important that the inscription conventions allow any kind of entity and relations (human and non-human) to be represented without any limitations, and the system is aware of generic type of relationships and thing.
Source **http://www.w3.org/History/1989/proposal.html** viewed 10 May 2015

Figure 4.4   The World Wide Web, first representation (circa 1989)

From the organisational point of view MESH was a management application to monitor the performance of research teams across global locations. This is an example of TEL research in the domain of computer science. How this works is described next.

An important aspect the design is the separation of the 'system' from the 'applications'.

> When describing a complex system, many people resort to diagrams with circles and arrows. Circles and arrows leave one free to describe the interrelationships between things in a way that tables, for example, do not. The system we need is like a diagram of circles and arrows, where circles and arrows can stand for anything. (Berners-Lee 1889, p. 7)

The system is a network of nodes (entities) and relationships (arrows) that can stand for anything human and non-human (see Figure 4.4). The entities are heterogeneous in including different order of things (e.g. people, systems, archives, and software applications) including hierarchal structures. For example, Tim Berners-Lee (the author) features as a node in the CERN hierarchical organisational structure (Figure 4.4). The proposal document is also a node. This is linked to the author by the arrow labelled 'wrote'. Other nodes are a mixed bag in terms of size, location, and ownership.

The MESH diagram is an example of abstraction that re-composes the world by asserting what is important. Things that appear incompatible are represented in the same way based on the same rules of inscription. The representation works by stabilising controversial and complex entities, thereby rendering what is contested and not-yet-fixed immutable and possible to circulate. By using formal notation of circles, clouds, and document(s), the complexity of connections are punctualised.

Abstractions are powerful because the inscription system is open to representing anything, and anything is possible to depict with a combination of arrows and symbols WWW was implemented and could be scaled up, as history has shown. However abstraction are problematic when they are taken as the objective essence of the thing, rather than design ideas materialised in the machine.

In terms of knowledge and skills, TEL researchers are not always familiar with the technical discourse of design engineering. Opening the black box is difficult. This is also true of funders and other interested groups, and is one of the reasons why 'the demonstration' has become a form of evidence that research has taken place. How

the demonstration is mobilised and translated is part of what TEL is and where it comes from, and this is discussed next.

Demonstration

In engineering disciplines, abstract knowledge is materialised by building physical artefacts. Engineering research proceeds by demonstrating prototypes, and then persuading the research community to take up these working designs (Vincenti 1990). In Latour's (1987) words, this is the paradoxical Janus face of materialising technology: "Once the machine works people will be convinced [ergo] the machine will work when all the relevant people are convinced" (ibid., p. 10). Latour is saying that technology design is validated if the relevant networks of funders, and other researchers, are enrolled. "Thus while it is being made it cannot convince anyone. It is only after … new trials imposed by new interest groups that the machine will *eventually* and *progressively* be made to work" (ibid., p. 11). So in what ways is 'the demonstration' part of the discourse history of where TEL research comes from and what it is?

The demonstration moves research, from the interior space of de(re)composition activity to the more public space of performance. Critically, the demonstration does different work depending on what subjects, institutions and discourses are mobilised. This diversity is shown in the three accounts : (1) where research by demonstration involves learning by construction; (2) where the demonstration is proof of concept; and (3) where the demonstration is vehicle for collaborative play and exploration. These three accounts are examples of how demonstrations *work* in ways that are enactments of discourse from engineering, but what happens is also emergent in its' effects.

Research by demonstration. The first account of R&D demonstrations point to the importance of the relationship between discourses materialised in the machine and credible accounts of what the machine is doing. To explain this it is worth noting that pre-digital demonstrations of TEL technologies were manufactured, and even sold, before they were published as TEL research. Examples are Skinner's Teaching

Machines (1958) and Pask's SAKI system (Haque 2007). However, this was more difficult to accomplish with digital technologies because in the 1950s it was a disparate set of piecemeal technologies. Today digital devices feel like one machine, and this hides the history in which its many components were developed separately. For example, different research groups worked on the graphical user interface, input devices like the mouse, multiple window management, and applications like word processing and so forth. The bits and pieces did not actually work together at the time and were certainly not portable enough to demonstrate outside the laboratory. In this landscape of bits and pieces, the demonstration was developed into a fantasmatic performance of digital possibilities. Ivan Sutherland's Sketchpad was influential in raising the status of the demonstration as a legitimates means to validate research.

Sutherland (1959) writes about research by doing: "The decision actually to implement a drawing system reflected our feeling that knowledge of the facilities which would prove useful could only be obtained by actually trying them. ...." (p.17). However, Sketchpad, the demonstration program, had limited distribution because it could only run on a customised machine at the MIT Lincoln Laboratory. Nevertheless, secondary accounts were enough to build an international network of supporters. The idea of demonstration mobilised a wide science network, even when a physical demonstration was not possible.

The Sketchpad won the Turning prize in 1988, but the judges did not see a demonstration; what they evaluated was Sutherland's PhD dissertation describing Sketchpad (1963), a TV program which demonstrated the Sketchpad (Sketchpad Demo at MIT Lincoln Labs 1964), and a widely cited conference publication (Sutherland 1959). This, is part of the discourse history of TEL in that the rhetoric of research by demonstration was translated to learning by doing when Kay (1972), Papert (1993) and others theorised constructionist and discovery learning with computers.

Demonstration as proof of concept. The second account illustrates the translation from the interior space of complex engineering to gathering, assembling and orchestrating in order to entice, communicate, persuade and generally engage and mobilise a wider audience. A much cited example of this is the retrospectively

named 'The Mother of All Demos' (Levy 1994; Markoff 2005). This was a technical demonstration by Englebart's research group (at the Augmentation Research Centre at Stamford Research Institutes). In effect, this was a performance in which a geographically distributed team showcased over 10 years work in 90 minutes (Englebart 1968; 2009[21]). Englebart's presentation employed the craft skills of live television production, complete with a camera crew, technical director, audio video narrative, a script with live action as well as opening and closing credits. Prior to the demonstration, Englebart and his team were regarded as 'old school' engineers and were largely ignored by and the more powerful alliance of researchers working in the emerging fields of computer science, artificial intelligence and cognitive science (Metz 2008). The demonstration received a standing ovation and national and international media attention. The event upgraded the status of the research, and many of the team and backers[22] were recruited to the commercial Research and Development (R&D) division at Xerox Alto Research Centre (PARC).

Over time the demonstration has been translated into multimedia performance in which the technology explains itself in collaboration with it's a master of ceremony. At these events demonstrations as performance entertainment and validation are inseparable. It is no accident that the launch of new Apple Company products was stage-managed by Steve Jobs as demonstration events (Isaacson 2013). The 'mother of all demos' led to the BBC UK *Horizon* investigation into microelectronics that is explored in Chapter 5.

Demonstration as a means of collaboration and exploration. In the third account, a demonstration in an education settings emerges as a form of TEL research. The example comes from the first private/public sector funded TEL experiment, a managed learning environment called PLATO. "The name 'PLATO' was chosen for its connection to teaching, and although it was typically capitalised in written materials, it was not an acronym for anything originally. Subsequently, the backronym 'Programmed Logic for Automated Teaching Operations' was invented to fit the name" (Elliott 2015, p. 1).

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[21] From You Tube Digital remastered from the original presentation – also in the archive collection.
[22] Backers were American Agencies: National Aeronautics and Space Administration (NASA) and Advanced Research Project Agency (ARPA)

PLATO originated in the early 1960's at the University of Illinois in one of the first Computer-based Education Research Laboratory (CERL). CERL was part of the engineering faculty, and PLATO hardware was designed by a group of electrical engineers (Bitzer 1988; Woolley 1994), and used by students, courseware authors and programmers. Don Bitzer, who led the team, was interested in improving classroom productivity through the use of computers for teaching, and it was this possibility that was used to secure extensive funding (Denenberg 1978).

To write the PLATO system software, Don Bitzer collected an eclectic staff of hobbyists ranging from university professors to high school students. Few of these enthusiasts had any computer background. These were not scientists or engineers inclined to defend "science and reason against pseudo-science, against fraud, against irrationality" (Latour 1987, p. 15). A typical researcher had technical skills, a limited job description and was motivated to socialise with other programmers by staying after work to "relax and unwind by playing some more aggressive games such as 'airflight'" (Denenberg 1978, p. 8).

During the 1960s and 1970s the system expanded from supporting a single classroom, to thousands of users over many sites (Perez & Mader 1999). In this process, the demonstration became a conduit for the envisioned and emergent developments of PLATO. For example a programmer was asked to develop a system for users to report bugs (Woolley 1994, p.1). The programmer explored design possibilities by building the demonstration and in doing so developed a reusable forum and conferencing system. Once there was a demonstration version of the system, it created its own milieu of use. There was already a physical group of people who played games and tried each other's software, so that what began as a demonstration became a core part of PLATO. The forum then made other developments imaginable and possible. For example, there were online conversations in the style of 'wouldn't it be nice if we could'. PLATO is defined by its relations with the researchers, who are also users, and users who are also learners. It is widely recognised as the first major social computing environment. (Plato culture of innovation panel video 2010)

The accounts in this section have illustrated how the demonstration has been deployed in TEL research. These accounts explain some of the disparities in how technologies in TEL research are constructed as factual (as described in the vantage point) but still leave open the possibility of emergent effects. The accounts also illustrate how demonstrations are performances that engage wider audiences by promising future possibilities that are described, demonstrated, or partly implemented. In this sense, the demonstration is an active non-human agency that continuously generates new and unanticipated effects.

(De)Stabilisations

Earlier in this chapter 'modularisation' was described as an engineering construct that makes it possible to mass produce complex technologies. Modularisation depends on reliable, interchangeable parts. Complex problems are decomposed into modular components with standardised and reliable input, processing and output. In this way modules are black boxes that can be assembled into complex systems. I have argued that the discourse from engineering that is - problem framing, decomposition and demonstration are the key to understanding the discursive shifts in how learning and enhancement are constructed in relation to TEL 'technology'. These shifts go some way to addressing my research questions, *What is TEL research?* and *Where does it come from?* However, from the vantage point of contemporary TEL research, digital technology is taken as 'fact', 'complete', 'done'? How is this possible?

The concept of stabilisation is useful for explaining the factualisation of digital technology. Stabilisation is an effect of increasing number of elements that are tied together so that it is difficult to reverse the investments. Latour (1987) describes stabilisation as a kind of reality making:

> If one wishes to question a fact or to bypass an artefact one might be confronted by so many black boxes that it would become an impossible task: the claim is to be borrowed as a matter of fact, and the machine or instrument put to use without further ado. Reality, that is what resists all efforts at modification, has been defined, at least for the time being. (p. 179)

This section is called (de)stabilisation, and this is because there is a tension between the emotional experienced of human machine interaction, and discourse materialised in the machine. Digital-human interactions can be experienced as "*reactive, linguistic,* and internally *opaque*" (Suchman 2007, p.35 italics in the original). A computer can seem to *react* in ways that feel intimate; interaction with a computer can feel like a *conversation*; and human projection can make the computer feel like a separate sentient being. This disrupts who or what is actually learning, and what counts as learning. Because of this, stabilisation can be variable. Stabilisation can be: (1) a discourse that materialises technology (how the machine does what it does); (2) socio-material relations in how technology is deployed (emergent phenomena in use); and (3) algorithms that seemingly deliver the 'knowing' capability of digital technology. Each of these appear in the accounts that follow.

Stabilisation as a discourse that materialises technology. The first account is about how design de(re)compositions described earlier in this chapter, are materialised and rendered stable. Programming is an example of making stability: "Programming is the process of translating information in the world into abstract objects which can be converted into program structures" (MIT lectures 1972). Notably, this process is one of going from ideas and wishes to absolute clarity: "A computer program is a message from a man to a machine. The rigidly marshalled syntax and the scrupulous definitions all exist to make intention clear to the dumb machine" (Brooks 1995). The 'computer program' is a series of orders organised into procedures and execution sequences that make the technology act.

Latour (2014) writes: "Any method we might adopt to follow an innovation can only aim to reconstituting both the succession of hands that <u>trans</u>port a statement and the succession of <u>trans</u>formations undergone by the statement" (p. 4, underlined from the original). In software design text, this succession of transformations by different specialists is often represented in layered diagrams (Sommerville 2010). The idea of layers as deployed in software engineering text was discussed earlier in the chapter in relation to decomposition of a problem from 'world view' to 'design view' and 'implementation view'. There are many different versions of the layers, which more often than not share the following three commonalities:

- The bottom layer is invariably about manipulating physical components (e.g. central processing unit (CPU), memory chips, sound card, video card, hard drive and so forth)

- The layers depict transformation of constructs that are familiar to people (e.g. 'learning', 'curriculum', 'knowledge' and 'enhancement') into to code that is machines can process.

- At the base level the machine is given instructions in the binary algebra of ones and zeroes.

The different layers are composed of many different components each requiring different kinds of training, expertise, and experience. Each of the specialisms is a subgrouping with a specialist vocabulary, rules of engagements, authorised actions and forms of control and surveillance.

The black boxes started closing with the commercial development of operating systems and the rapid rise of the personal computer industry. Predictably, both are complex assemblages that are costly and difficult to undo (Campbell-Kelly et al. 2013; Myers 1996; Pugh 2009). TEL researchers are from many different disciplines, and they experience the black boxes of technology as opaque in different ways. This goes some way to explaining why, from the vantage point described earlier in this chapter, technology is factualised. It also explains why research into 'learning' and 'technology', which has a history of co-location is sometimes invisible and sometimes rewritten as a problem of interdisciplinary collaboration.

Stabilisation as socio-material relations. The second account is about stabilisation when increasing numbers of heterogeneous elements are tied together in mutually dependent relationships. This is illustrated in an experiment called Computer Based Living-Learning and Information Exchange, which was set up by Berkeley graduates (Lipkin et al. 1974). A flyer for the project described the time and place:

Our intention is to introduce COMMUNITY MEMORY into neighborhoods and communities in this area, and make it available for them to live with it, play with it, and shape its growth and development … With this, we can work

on providing the information, services, skills, education, and economic strength our community needs. (Loving Grace Cybernetics 1972).

According to an excerpt from the mimeographed guide, the system was described as a form of social networking:

> COMMUNITY MEMORY is a kind of electronic bulletin board, an information flea market. You can put your notices into the Community Memory, and you can look through the memory for the notice you want. (Guide to Using The Community Memory circa 1972)

Hernandez (2012) describes the set up as "Facebook?! Twitter?! Instagram?! We did that 40 years Ago" (p. 2). The project was an early example of a lifestyle online social media community. For the community to be sustainable the elements had to be tied together and maintained. There was, for example, equipment and infrastructure which included a series of terminals around San Francisco and Berkeley and connection to a main frame computer with capacity to host a database (Slaton 2001). Then there was a team of workers with expertise: "Lee took care of hardware, Efrem software, and Mark user interface and information husbandry" (Lipkin et al. 1974). The project was only possible because digital technology enabled new forms of communication: "Anybody could *Add* a message, attach keywords to it, and *Find* messages" (Szpakowski 2006 p. 1, italics in the original).

Two other associations are noteworthy:

1. The *Whole Earth Catalog* launched by Steward Brand in 1968 was regarded as ground-breaking attraction for a loosely knit counter-cultural socio-political community, and the 'Collective Memory' project was positioned as a digital extension:

   Users would post about the topics of the day, discussing Peoples' Park, the Grateful Dead, Vietnam. They'd post things that were personal, or funny, or sarcastic, or revelatory. "Somebody posted asking where you could get decent bagels, which at the time was a near impossibility," says Lipkin. "But within a day or so someone who was a bagel maker offered to teach him how to make

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them. I was so surprised by that – someone offering to teach and engage a stranger." (Slaton 2001, p. 2)

2. The project was sponsored by a local publication called *Resource One Newsletter* (Number 2 April 1974, four page insert). This is interesting in its affiliating an essentially hobbyist small scale project with TEL research at the time. This is evident in depicting 'learning with computers', digital networks, a conference around TEL themes, an advert for the 'Community Memory' and an example of command sequences in the same space (Szpakowski 2006).

'Community Memory' was a short-lived project and was over taken by online communities on the internet and eventually the WWW. What the project demonstrates is the materialisation of a discourse in which technology, ideas and people assembled in a way that is different from the discourse of problem framing, decomposition, and demonstration in the academy, or the stability of separation and black boxing in commercial R&D. The Community Memory and many other projects like it suggest that neither people nor technology are passive components of design or entirely in control of how relational connections are played out. It is also a reminder that stabilisation can be short lived.

Stabilisation as algorithms. The third account is about the (de)stabilisation of digital-human relations. Like those involved in the 'Community Memory' Project, many researchers embraced experimenting and building by trial and error (Kay 1972; Papert 1993; Woolley 1994). Boden's (2006) two-volume history of cognitive science describes a different kind of stabilisation, indeed a different regime of knowledge production, one in which the objective is to demonstrate the equivalence of 'Mind and Machine' by implementing the fundamental properties of the mind in the machine. Boden writes that the mind is a shorthand for "all mental processes" (p. 10), which include: intelligence, language, memory, perception, problem solving, emotion and social interaction, and, across all of these, learning (Buchanan 2006; Miller 2003). I bring this in here to draw attention to the differences between TEL research in R&D commercial laboratories, in hobbyist counter-culture projects, and in emerging cognitive science laboratories. By the 1970s, demonstration of working programs was the gold standard for validation of research claims in computer

science. Allied researchers in cognitive (learning) sciences aspired to program elements of 'intelligence' into digital technology, build expert tutoring systems and design algorithms to demonstrate machine learning.

Researchers who are close to the unstable mechanics of software and hardware engineering are sometimes incredulous of public and media perception that engineering can produce anything like a brain or universal answering machine. However, if we consider AI on the web, and if success is defined by the experience of machine intelligence in digital-human relations, then there are some major application areas that behave in dependable and responsive ways. Search engines, speech recognition, machine translation of human languages, and question answering all come from AI research and all of them rely on 'trainable' probabilistic models (Norvig 2011). In addition, there is now a long list of intelligent tutoring systems that claim to be operational in large scale learning environments (papers from Pittsburgh Science of Learning Center). These systems are described as adaptive. In other words, they learn from experience (of processing data input) so that the algorithms are self-determining in how the machine responds in conversations with other entities (humans or machines). Algorithms which implement fuzzy logic and neural net technologies perform machine intelligence. This is another enactment of discourse materialised in the machine.

This section has described three examples of (de)stabilisation. The discourse of systems engineering is enacted in the separation of expertise, and black boxes within black boxes evolve into 'facts'. The alliance of counterculture networks in the 1970s was the beginning of fantasmatic hope and fear in relation to specifically digital technology. Research from cognitive science and AI has been stabilised into 'knowing' algorithms which perform machine intelligence. This is part of the discourse history of 'technology' in TEL research.

This chapter ends with a summary of how the analysis in this chapter has been staged. An overview of this is illustrated in Figure 4.5.
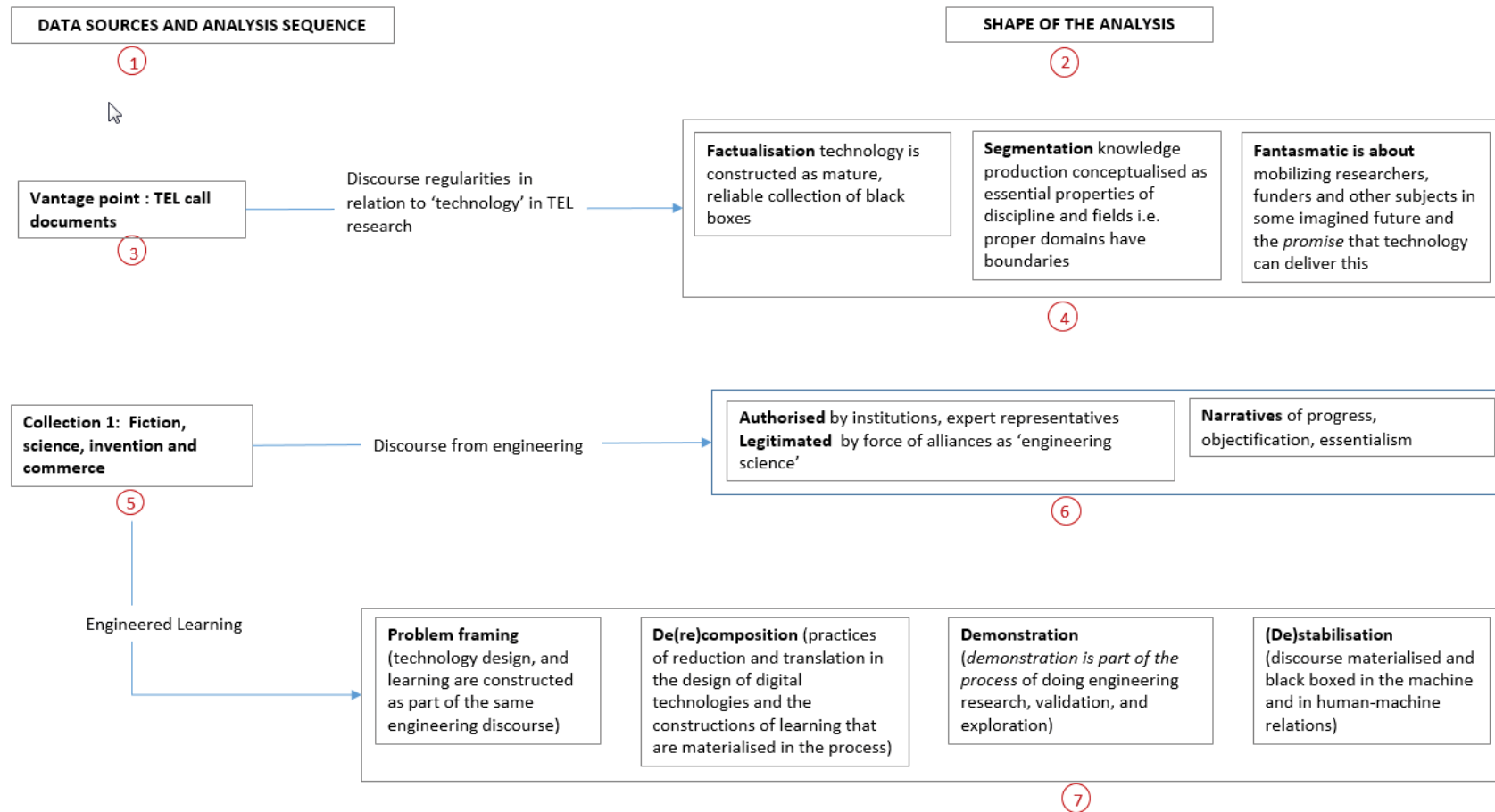
A schematic view of Chapter 4 illustrating the relationship between data, and sequence of the analysis. The three main sections (4, 6, 7), and key points in relation to discourse regularities at the vantage point, and the discourse history of 'technology' in TEL research

Figure 4.5:   Relationship between data, and sequence of the analysis in Chapter 4.

Materialising discourse: a summary

Working with a combination of Foucauldian discourse analysis and concepts from actor-network theory, this chapter has examined discourses materialised in digital technology generally, and in learning applications and projects in particular. The organisation of the analysis is experimental in its working with archival data and in the sequencing and shaping of the analysis (Figure 4.5: 1, 2).

I worked backwards from a vantage point of the TEL call documents (Figure 4.5: 2,3). The analysis characterised contemporary discourse regularities in the construction of digital technology in learning (Figure 4.5:4). The regularities characterised technology in TEL research as reliable, advanced, stable and complete. Moreover technology research and learning research were asserted as separate fields that should be working together. The future of technology in TEL research was described in terms of the harnessing and exploitation of digital technology in order to realise the fantasmatic future of personalised, flexible learning, increased productivity and social inclusion. These regularities were described as 'factual-isation', 'segmentation' and 'fantasmatic' (Figure 4.5:4).

The rest of the inquiry traced the discourse history of TEL in order to examine where these discursive regularities came from (Figure 4.5:5). Empirical relations to discourse from engineering (Figure 4.5:6) were described, followed by multiple accounts of how these relations were translated into discourse that engineered learning in the design of TEL applications, and in human-machine interactions (Figure 4.5:7).

While this summarises the shape of the analysis, the history of materialising discourse is not so coherent. At times some of the accounts in this chapter seemed to unfold in a private and specific historical-geographic space: imaginary machines, stores of human knowledge, visions of some greater good alongside chaotic laboratories in engineering faculties where unstable computers break down often: public spats between behaviourists and the forerunners of cognitive science and, 40 years later, between ancient cognitivists and Google AI scientists; the illusion of programming as magic and programmers with no illusions about computers being

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anything like human brains; the demonstrations that never left the laboratory, and the demonstrations that were media events; the new-fangled gurus with cult followings, and the 'dudes' (there is no female equivalent) visiting the community memory terminal at Leopold's records in Berkeley. It might seem that rather than revealing the discourse materialised in the technology, these are minor cameos. On the contrary this chapter has demonstrated that regularities, as they are enacted, may be historically and geographically specific but the strategies of stabilisation and translations have relevance beyond specific instances.

The discourse materialised in the machine was described in accounts of 'problem framing', 'de(re)composition', 'demonstration' and '(de)stabilisation' (Figure 4.5:7). Although I have taken the analysis up to 2012 by referencing the WWW and machine intelligence, a black box of technology in TEL research began to close with the commodification of digital technologies. Microsoft was launched in 1975 and by 1990 the company had captured 90% of the market share of world's personal computers (Allan, 2001). Apple Inc. was incorporated as a company in 1977. With the introduction of iPod digital music player in 2001 and the iTunes Music Store in 2003, Apple both dominated and created the market in consumer electronics (Isaacson 2011). This is relevant because specialisation is increasingly necessary to sustain the commercial demand for computing devices and the infrastructures of ICT consumption. Importantly this has changed the discourse history of TEL research.

This chapter has traced the discourse history of TEL research, from 1945, when prospect of any digital consumer goods was uncertain, to the materialisation of discourse in the machine. This is important because discourse materialised in the machine is increasingly invisible but still effectively controls what is possible to think and do in the name of TEL research. Today there are thousands of TEL researchers, but where have they come from? TEL research is no longer confined to academic research. What other networks are involved? For some researchers, computing consists of numerous black boxes. There are black boxes within black boxes. What happens when TEL researchers are users and not developers or designers of technology? There are some TEL researchers who design and develop technology, but then what happens to learning?

These questions are taken up in Chapter 5 in a study of the translation effects. In writing what Latour (2004) calls "risky accounts" (p. 121), it becomes all too clear that there are things that don't fit, not least the contradicting accounts of digital-human configurations and how these are (or should be) materialised. This non-coherence is taken up in Chapter 6.

Chapter Five: Translation effects

Translation is not deterministic nor linear, for what entities do when they come together is unpredictable, they negotiate their connection, using persuasion, force, mechanical logic, seduction, resistance, presence and subterfuge. (Fenwick & Edwards 2011, p. 98)

Introduction

This chapter is about the discursive work involved in constructions of '*learning*' in TEL research. In the late 1970s the stabilisation of hardware components of digital technology made personal computers commercially viable, so that by the 1990s digital products and services were being manufactured and managed on an industrial scale (Wurster 2002). During this period, institutions and organisations associated with mass media, business, and government, were active in seeking to shape TEL research, and these associations were influential in changing the discourse of learning. Therefore this is part of the discourse history of *what TEL is and where it comes from*. Actor-network theorists, describes change as the work of translations. Latour (2014) describes translations as the "progressive construction of reality" (p. 27), and this involves displacing one program of action with another program of action. Discursive work makes translations possible and this entails, amongst other things, struggles, negotiations, accommodations, prescriptions, persuasion, inclusions and exclusions (Fenwick & Edwards 2010). This chapter examines discursive constructions of '*learning*' emerging from networks that were active in these struggles.

In Foucauldian terms, various interruptions have forced the discourse of learning to enter new times and move towards new types of rationality (Rose 1990, Foucault 2002). For example, in the UK reporting on the growing micro-electronics industry in the US raised public awareness, and governmental fear, that UK was lagging behind in the worldwide technology race, together with the race for a highly skilled and productive workforce (Young & Gardner 1981; Forester 1989). A different kind of interruption came from business and commerce when the word 'e-learning' entered the TEL vocabulary in the early 1990s (Hammond 2003). Parallel to this in

the mid-1990s, politicians and policy makers questioned the value and quality of education research, especially in terms of its relevance for policy and utility for practice (Blunkett 2000; Davies 2002). By 2006, TEL research in the UK was part of the largest funded *Teaching and Learning Research Programme* in the UK (TLRP). This chapter will retrace this UK-based history, and track the simultaneous shifts in constructions of 'learning' the 'learner' and the discourse of TEL research. This extends the accounts in Chapter 4, examining in a different way *What is TEL research?* and *Where does it come from?*

The chapter begins by setting the scene. In this I describe the problematic of '*learning'* in TEL research and how this relates to objectivity, essentialism, progress (as discussed in chapter 4). The remaining four sections of this chapter are:

- *Collections 2 and 3: Mainstreaming and crises*. This short section describes the material (data) that are analysed and referenced in the rest of the chapter. The selection of materials illustrate that as digital technology and services were industrialised, the discourse history of TEL research changed.

- *A vantage point: 'learning' in TEL research*. Working on data from Collection 4 as a vantage point, the analysis in this section identifies three discourses from policy, business and media; and three regularities that work to (re)construct '*learning'* in TEL research. These are described as 'homogenising of research', 'quantification' and 'opaque accountabilities'.

- *Translation of learning*. This section constitutes the bulk of the chapter. It is about understanding where these discourses and regularities come from, and it is divided into four parts. The first three parts demonstrate that TEL discourse is located in three different networks, which translate TEL research and construct learning and the learner in different ways. The fourth section is about TEL research in the academy, and in particular the translation effects of discourse from outside the academy on disciplining TEL researchers.

- *A summary: Mesh-up effects*. The chapter ends with a summary of how translations have shaped TEL as a field of inquiry, this is described as a mesh-up of conventions and authorisations. I argue that that in spite of the

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extraordinary ubiquity of digital technologies for teaching and learning, the scope of TEL inquiry is narrowing to fit the political exigencies of funding regimes.

Setting the scene

In Chapter 3, I analysed conceptual resources from Latour (2004), Law (2005) and Foucault (2002), and used their ideas to argue that archival materials on the internet are effectively traces of discourse history. Chapter 4 examined *where TEL research comes from and what it is* by examining materials in Collection 1, and tracing discourse(s) materialised in the design of digital technologies. The analysis demonstrated that the commercial opportunity afforded by the combination of reduction in cost, increased connectivity, and usability of digital technologies, mobilised networks in commercial R&D and hobbyist groups in the USA. In practice this meant that digital technology was modularised into commercial products and services, it was increasingly black boxed and transported across time and space and application domains. This chapter moves forward to the late 1970s, when the mass production of digital logic circuits was well under way for industrial applications, but the associated technologies were not yet consumer goods that the public could afford (e.g. computers, mobile phones and the internet). The personal computer had not yet arrived in the UK.

In Chapter 4, '*learning'* was analysed in relation to the discourse materialised in the machine and traced to research in cognitive science, and related fields like artificial intelligence. As a reminder here are some of the constructions that are materialised in the machine:

- learning is a problem to solve by systems analysis and decomposing the requirements of the teaching task;
- learning takes place by doing and this means building demonstrations, designing applications or experimenting with simulations;
- intelligence generated by machine learning is a resource for human learning.

However outside of these early TEL investigations, research into *'learning'*, rather than say education, is a relatively recent phenomenon in many disciplines including psychology, pedagogy, training, education and professional development. Its currency in the professions and in political and economic discourse is also recent (Illeris 2009). This is also the case with the focus on national auditing of quality, amount and level of *'learning'* as parameter of global competitive advantage (Gorur 2012).

Writers who are influenced by actor-network theory and Foucault recognise that the focus on learning and lifelong learning is a late-modern phenomenon and not given in the order of things (Edwards et al. 2004; Chappell et al. 2003). They are careful about acknowledging their assumptions and questions. Here are two such examples:

- Fenwick et al. (2011) write: "Let us begin by acknowledging that, by education, we mean international activity to promote learning for particular purposes in any situation: classroom, worksite, virtual spaces, mentoring meetings, community projects, social movement, and so forth" (p. vii).
- Nespor (2012) writes: "How do we know that people *born* with limited or no hands, who cannot move their bodies through the world at will or without the use of 'instruments', become recognisable as intelligent and potentially communicative?" (p. 11 italics in the original).

These insights suggest that learning, acting with knowledge, intelligence, and communication are all tied to extended networks of human material relations. In this network of things, a key entity is the subject, in other words, the learner. This chapter traces changes in constructions of 'learning' and the 'learner', and how this relates to the discourse materialised in digital technology.

Previous chapters discussed the reasons for drawing on wide-ranging sources of data, and the metaphorical 'vantage point' was introduced in Chapter 3. As in Chapter 4, the vantage point is taken as the UK TEL call for funding documents (2006, 2007). This chapter draws on data from two additional collections. The collections and materials are introduced next.
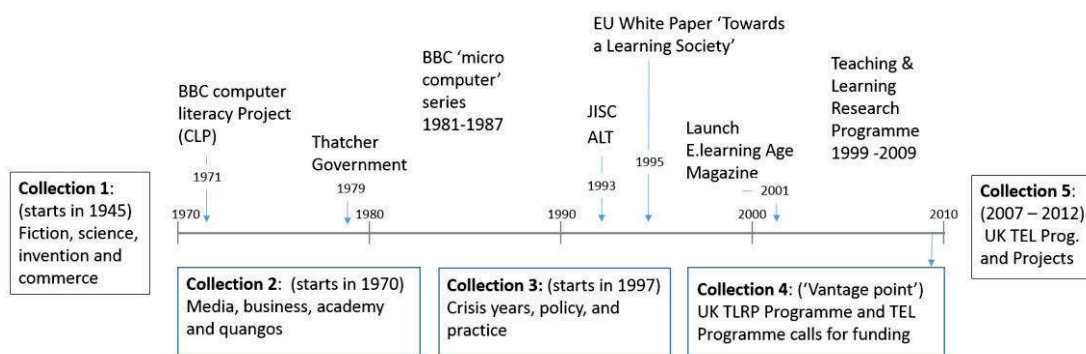
A schematic (not to timescale) view of the Collections showing the 'vantage point', and historical markers that are referenced in Chapter 5

Figure 5.1 A schematic view of Collection 2, 3 and the 'vantage point'.

Collections 2 and 3: Mainstreaming and crises

The data in this chapter comes from come two collections:

- Collection 2: media, business, academy, and quangos
- Collection 3: crisis years, policy, and practice

The schematic representation of the five collections in Figure 5.1 is a reminder of how these collections relate to the vantage point (collection 4). Figure 5.1 also indicates some of the key events and materials discussed in this chapter.

The presence of national and international organisations that broadly fund, commission, manage, review, and monitor TEL research are more or less taken for granted today. This has not always been so, and Collection 2 is materials from this history of emergence and mainstreaming. In the 1980s the BBC *Computer Literacy Project* (CLP), located in the BBC's *Continuing Education Television* Department, set out to "bring education to the people" (quoted in Blyth 2012, p. 9). In the process, both the invention of the personal computer and what counts as learning escaped the confines of laboratories and institutions of formal education.

Table 5.1 Examples of materials from collection 2, 3 and 4 that are cited in chapter.5

Formats include: text in print and online as html and pdf, video footage in you tube, closed forums, multimedia demonstrations, social media, internet archives

Networks	Organisations, events, people, and things	
BBC Computer Literacy Project	Open University (Literacy Program) BBC *Continuing Education Television* Department BBC lecture series, Centre for Computing History archives BBC Enterprise, BBC Publishing, Acorn Computers BBC Series 1980 - 1987	(Allen & Albury 1980; Blyth 2012; Nelson 1973; Radcliffe & Salkeld, 1983) Micro user magazine, April 1985 (Meakin et al. 1985) Advertising archives, BBC micro system, circa 1980
Business and E-learning providers After 1990	Global 5000 training provides: SmartForce Training Provider SkillSoft Corporation, BIZMEDIA publications	(Cross, 2008; Wright & McMahan 1992) e.learning age archives Bizmedia Ltd (Mort 2003)
Policy and governance	Thatcher government, Blair government Education Policy, Research funding Archives: Joint Information Systems Committee (JISC) Association of Learning Technology (ALT)	DFEE 1998; Hargreaves 1996; Jones 2003; Plowden 1967; Tomlinson 1996; Dearing 1997; DFES 2005, DERA archive
Academy TLRP Programme & TEL call for funding 2006 -2008	Centres of Excellence ESRC, EPSRC, CSCW, HCI, CSCL, AI TEL journals and conferences UK Government office European Union (EU) Commissioned and Funded TEL Programmes	Carroll 2003; Card et al.1983; Coffield 2000; Conole & Oliver 2007; Davis 2002; Engestorm 1987; Fowler & Mayes, 1999; Suchman 1987; Wanger, 1987; Whitty 2006

In the 1990s specialist terms like e-learning and learning technologists entered into accounts of TEL research. TEL researchers were drawn into knowledge production practices from business and policymaking. In the UK, new professional bodies were being funded and were thriving. There was a blurring of boundaries between academic research networks (located in research centers and R&D laboratories), and quango networks funded by government, commerce and professional associations.

Collection 3 is called 'crisis years, policy and practice', because of the controversies around the relationship between research, policy and practice in education. This starts in 1997. In the UK this was marked by the New Labour government's commitment to evidence-informed policy (Whitty 2006). The idea that learning and technology are central to national effectiveness, competitiveness and social justice has become widespread, but this has not always been so (Murphy 2005). The term 'crisis' is used to capture something of the recriminations around public money being spent on education research *without* evidence of progress at an acceptable rate (Coffield 2000).

Some of the materials from these collections is illustrated in Table 5.1. The table is organised to show the networks involved in the translation of '*learning*' beyond the boundaries of academic TEL research. It also shows that this changed constructions of '*learning*' and the '*learner*' in academic research published for peer audiences and, in a series of reports produced by committees of academics, for policy makers. The latter include various roadmap documents, agenda-setting reports and grand challenges and these are identified in Table 5.1.

A vantage point: 'learning' in TEL research

To understand translations of what *TEL research is and where it comes from*, I start with the UK TEL call for funding documents (2006, 2007). Working with conceptual resources described in Chapter 3, these documents are understood as an assemblage of discourse(s) and discursive regularities that construct 'learning' and the 'learner' and by association *what TEL research is*. Analysis of the TEL call documents suggested the presence of at least three different discourses.

The first discourse is about the relationship between research and practice. This discourse works by connecting TEL research with governmental policy goals so that the conditions for funding are formulated in relation to policy. Consider the opening statement in the second TEL call document (2007):

> E-learning, or technology enhanced learning (TEL) has been identified as being of key importance for the UK government and there are official

strategies in relation to particular educational sectors ….. This [TEL] programme of research will build strong conceptual foundations in an area that is recognised as crucial to the future of learning in the UK but which also has global implications. (p. 1)

This statement locates TEL research within the education sector. In addition, research in general and TEL research in particular are asserted as being a policy instrument that is responsible for delivering the future of education. For example these two statements appear in both the Call documents (2006,2007), and are not unusual:

[The Programme] "aims to accelerate the transformation of the relevant fundamental research to applications that will have economic and societal benefits." (p. 3)

[Projects will be funded that can] "demonstrate anticipated strategies for knowledge transfer application and renewal to high leverage bodies related to the education professions, the learning technologies industry, policy-makers and the wider economy." (p. 7)

There is an expansiveness in the challenges set for TEL research that deals in broad social and economic categories, and in foregrounding "productivity, value for money and development of human capital" (pp. 2-4). Research funding is justified in terms of national policy concerns about social cohesion, global competition, and the economy. In this discourse, TEL research is constructed as a policy instrument for delivering societal change.

The second discourse is about the business of 'e-learning'. The first TEL call document (2006) described e-learning as cutting across disciplines, and public and private sector interests. The competitive language of business is there in statements about how every member state of the Europe Union has an e-science programme, and the repeated message that potential applicants are expected to demonstrate how their TEL research will add value to existing investments in e-learning by

government, and business. In this discourse '*learning*' in TEL research is about services and products developed for commercial competitive advantage.

The third discourse is about engaging the audience. This is interesting because the validity and relevance of research in education is traditionally judged by peer review. In the TEL call documents, there is an imperative to engage a wider audience and this compels TEL researchers to explain the relevance and validity of their work to 'outsiders'. As part of the conditions for funding, TEL researchers were required to demonstrate: "User engagement, knowledge transfer and impact" (2007, p.7). Projects bidding for funding were required to budget for dissemination events, and declare the types of audience that would benefit from the proposed research. In this discourse, '*learning*' is validated by its capacity for audience engagement, appeal and approval.

I am not suggesting that these three discourses are mutually exclusive or exhaustive. However, I do suggest that these discourses discipline TEL researchers to construct '*learning*' and the '*learner*' in particular ways. Discursive regularities are the apparatus of discourse, that is how discourse works to construct *what TEL research is*. Three regularities are now described. These regularities are not separate from regularities discussed in Chapter 4 (and yet to come in Chapter 6). Empirically, the descriptions of these regularities are ways into tracing translations that are part of the discourse history of TEL research. Each regularity will now be described.

The first regularity is the homogenising of what counts as TEL research. Metaphorically, the term homogenous suggests an assimilation of differences. For example irrespective of differences between what counts as research in academic disciplines, R&D, voluntary sectors, industry and professional bodies; TEL researchers are called on to see "the bigger picture in pursuit of innovative, creative and exciting solutions to supporting learning across context, …" (ibid. 2007, p.4). The implication is, that research is neutral, and transferable, and TEL researchers are providers of homogenous products and services that can be compared in terms of costs and value. A different (counter intuitive) example is that, in the TEL call documents (2006,2007), discipline-based research is described as an impediment to progress. Homogenising in this case is about compelling researchers to fix, or

reconcile, or in some other way manage disciplinary differences. As a condition of funding, researchers are asked to show how they will deliver "Authentic interdisciplinary integration and innovation.." (p.6). This first regularity channels researchers to write bids in which differences between 'learners' and 'learning' are decentred, and the subject of inquiry is the "big picture" (ibid, p.4) processes and products.

The second regularity in the TEL call documents is about quantifying research outcomes. This is most stark on the theme of 'productivity', which calls for quantification of how teachers and learners "can achieve more" in the "time invested" (2007, p.9). The vocabulary of quantification is illustrated in this statement about the intention of funding TEL research (Second Call document 2007):

> The intention is to inform the development of practice, innovation, and investment policy. In particular, proposals are invited which contribute towards an evidence-informed analysis of the benefits and costs of personalisation of learning through technology across the life-course. (p. 9)

Researchers from some disciplines find it puzzling, if not banal, that such calculations of costs and benefits are thought to be possible. The language of quantification veers towards specificity: "what outcomes?", "whose outcomes?", "how enhanced?", "what intervention?", "when and how will the intervention take place?", "what is the evidence?", "how will the evidence be collected?", and "how will effects be shown?" (ibid. 2007, pp.5-9). Researchers are invited to be creative, but the regularity is powerful and excluding – "proposals which were unsuccessful under the first call should only resubmit if substantially revised" (ibid. 2007, p. 5). The second regularity channels TEL researchers towards writing bids that exclude the speculative or novel in favour of the quantifiable and predictable. There is also an important (albeit complex) bilateral connection to the engineering narratives of progress, objectification, and essentialism; and the discourse materialized in digital technology (see Chapter 4).

The third regularity can be described as opaque accountabilities. Accountabilities are how TEL researchers are held answerable for being awarded public funds. In the

TEL call documents statements about accountabilities are not consistent. Some of the statements are policing, and attempt to control what will count as TEL research. At the same time, accountabilities are opaque because TEL researchers are invited to transgress disciplinary and other boundaries and redefine what counts as research and knowledge. This regularity works by subterfuge. Successful TEL researchers are in Foucauldian term knowing subjects. They win funding by writing in ways that resonate with particular kinds of audiences, including funders, and peer reviewers. This is only possible by smoothing over the contradictory values and the conflicting research agendas in ways that resonate with the fantasmatic vision and promise described in Chapter 4. Opaque accountabilities enroll particular kinds of subjects: TEL researchers who are willing to speak of the greater 'good' while pragmatically leaving open what this means in practice.

The discourse of *'learning'* within the TEL call documents (2006, 2007) suggest the influence of networks beyond the academy. The presence of different discourses in the text of the call documents (2006, 2007), along with the performativity of regularities, raises questions about where this construction of TEL research comes from. In the rest of this chapter, these networks and discourse regularities are examined to trace translations in constructions of '*learning'*, the '*learner'* and TEL research.

Translations of learning

Returning to the question of *What is TEL research?* and *'Where does it come from?* So far in this chapter I have come to some conclusion about the construction of 'learning' and the 'learner'. From the vantage point of the TEL call documents (2006, 2007), I described three regularities: *homogenising* differences works by disregarding the specificities of teaching and learning; *quantification* works by primarily recognising outcomes that can be measured; and opaque accountabilities both prescribes research deliverable and invites creativity and innovation. If this is some of the construction of 'learning' in TEL research (from the vantage point) then *Where doe this TEL come from?*

The rest of this chapter addresses this question by examining the effects of four different networks that are connected to the discourse history of TEL research.

These are:

1. Broadcast Media: (democratising computing)
2. Business: (the 'e-learning' providers)
3. Policy: (evidence based practice)
4. Academy: (disciplining research)

The focus on these networks is prompted by the materials in the collections. Latour explains that networks can be "*traced* … in the scholar's accounts" (Latour 2004, p. 108 italics in the original). The section on broadcast media (democratising computing) commands a larger section of analysis because of there were more traces, that is more source material in the thesis archive. It is as well to acknowledge that scholars' accounts are invariably selective, and so are the materials in Collections 2 and 3 and the translations that are described.

Translations involve relations between networks that are uncertain and controversial before associations stabilise into an established discourse (Latour 2005; Law 2004). Sometime translations end in disjuncture and betrayal and this too is part of the translation effects (Callon 1989). In addition the emergence of network connections has not been wholly chronological or mutually exclusive so at times the effects are contradictory and this ambivalence is taken up in Chapter 6.

Each network is considered in turn and the accounts are organised to include the following:

- identification of the network, and the particular problematising of learning;

- characterisation of the translations in that network, and the discourse(s) that emerged;

- widening the account to describe effects on constructions of learning, the learner and TEL research.
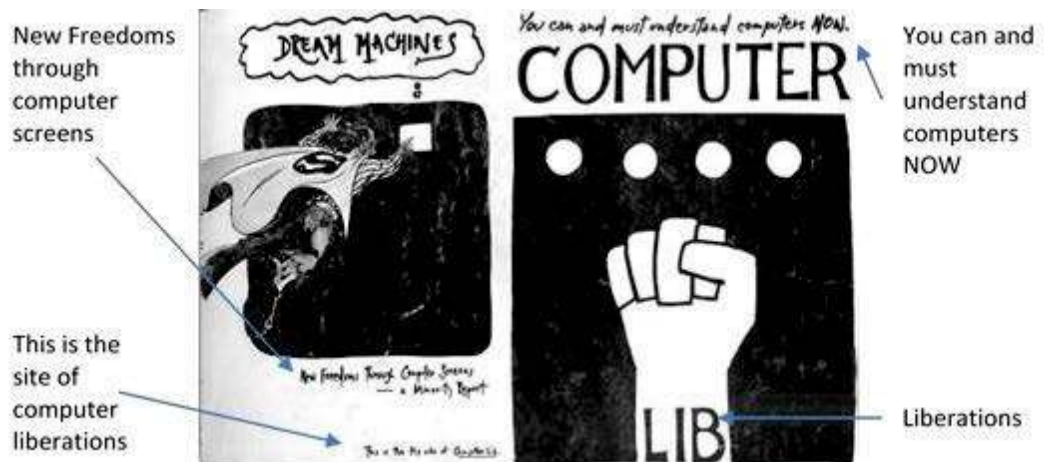
Figure 5.2   Cover from the Liberation Democracy.

Broadcast Media: (democratising computing)

In the UK the British broadcast media is part of the discourse history of TEL research. Since its inception the British Broadcasting Corporation (BBC) has had an educational mission (Sargent & Tuckett 1997; Blyth 2012). The Corporation played a prominent role in the literacy campaigns of the 1970s and in the development of the Open University (Hamilton & Merrifield 1999). In the late 1970s and throughout the 1980s, the BBC *Computer Literacy Project* (CLP) problematised UK's capacity to compete in the global digital technology markets and promoted the "grand ambition to change the culture of computing in Britain's homes" (Blyth 2012, p. 7).

In Chapter 4, I described the 1970s hobbyist culture of computing and the influence of the counter culture movement in the 'Community Memory Project'.   In his *Liberation Democracy Manifesto,* Ted Nelson (1973) famously wrote "Computers belong to all mankind" (Figure 5.2) The manifesto cover showed a superhero flying to a computer screen with the caption: *New freedoms through Computer Screens – A Minority Report*. A clenched fist spoke to passions of the times aligning the computer with political campaigns against tyranny and injustice (1974, p. 1).

The diagram has been redrawn to make it legible

Responsibility for the Computer Literacy Project spread across BBC departments which connected to external networks. The box marked "?????" represented a possible consumer market. Originally estimated at 12.000 machines.
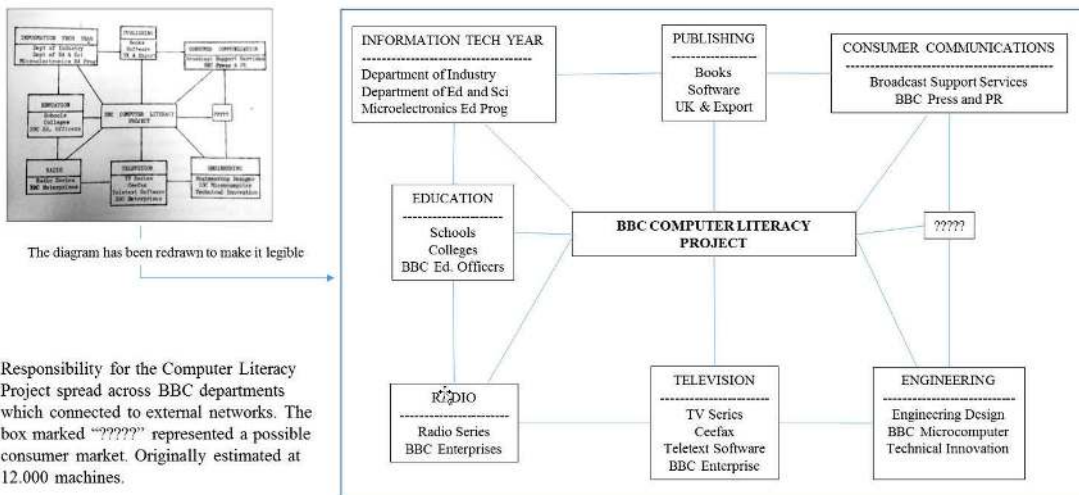
BBC archives 'First Byte' in File WW4/1, 442/1 . Reproduced in Blyth, 2012: 15

Image from the about the UK BBC Computer Literacy Project (CLP) 1979 -1987. This diagram was generated in one of the team meetings.

Figure 5.3   Representation of the UK BBC Computer Literacy Project (circa 1978)

Allen David the project editor of the BBC Computer Literacy Project said: "The aim was to democratise computing. We didn't want people to be controlled by it, but to control it" [23]. In the UK, television presented an attractive career proposition for the counter-culture generation, and slogans like 'education for the masses' and 'educate, entertain and inform' were taken seriously as commercial goals. It was in this climate of media interest in computing that the BBC broadcast the *Horizon* documentary*, Now the Chips are Down* (1978), and ITV's *The Mighty Micro* (1979).

The fantasmatic association between human progress and technology generated widespread concerns about the British people being left out of this technology revolution. Parliament debated the future consequences for UK employment and work, and in 1981 The Microelectronics Education Programme (MEP) was

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[23] David Allen at the Beeb 30th Anniversary panel debate held at the Centre for Computing History, at ARM, Cambridge, 25 march 2012.

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announced (Fothergill 1981). In early 1980s, Sheila Innes[24] commissioned David Allen and Robert Albury to make a documentary, saying: "There is this thing called microelectronics, I want you to find out if there is anything in it" (Allan, 2013). Their investigation was partly funded by government and set out to document international developments in digital technology applications. The report argued that computer literacy was not just about using the machine, but also meant knowing how the machine worked. On the *Computer Literacy Project* (CLP), executive producer, John Radcliffe, commented: "No other broadcasting organisation in the world could do this. We have the range of skills at our disposal, the educational commitment and the status in the country to get it together"[25.]

Tactically, CLP was spread across a number of BBC departments, including education, communication, engineering and consumer affairs. It was presented as relevant to all, and reached out from the BBC departments to enrol their connections with other institutions (Figure 5.3). The BBC was a powerful national network in a position to legitimise informal 'learning by doing' (outside of accreditation and assessment), and to enrol advocates across society. Furthermore the BBC *Continuing Education Television* Department already had a strong networks among providers of adult and non-traditional learning and an ongoing dialogue with educational advisors. Blyth (2012) quotes Innes as saying "We need them as much as they needed us … if the BBC's programming and approach was to be adopted by the schools and colleges" (p. 9).

The BBC Continuing Education Department had already delivered an adult literacy TV series, *On the Move,* and through this had developed an outreach network, and the CLP adopted this (Figure 5.3). This meant that viewers were offered not just a television programme but also courses, supporting books and software (Allen & Albury1980). In addition, working with the Broadcasting Support Service (BSS), and with financial support from the National Extension College (NEC) and the Department of Trade and Industry, organisations were invited to register as reference

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[24] Head of BBC Continuing Education 1977-84, Controller Educational Broadcasting 1984-87. (Sleeman, 2002)
[25] Notes from David Allen's Talk at the National Computing Museum on, *the Backstory of the 1980's BBC Computer Literacy Initiative.* 14 November 2013.

points. Within a month 800 agencies registered, including adult education centres, universities and computer clubs. Even while this momentum was building up, how this would work in practice was still uncertain: "The formative research had revealed wide variations in expertise, expectations, and need on the part of potential viewers…" (Radcliffe & Salkeld 1983, p23-24). Much of the uncertainly was around the pedagogy of teaching computer literacy, and access to technology.

As the scope of the CLP was being defined, the programme developers were faced with the problem that there was no readily available public access to a computer and no standard language. The personal PC did not exist as we know it today. The broadcasters wanted a machine that could be used not only for programming but also for graphics, sound and vision, and controlling other devices. Critically, this vision put the emphasis on investigative learning and problem solving with computers. In this sense users were the learners and learning was problem-solving research. Interestingly, the problem of there being no affordable, open-architecture personal computer available in the UK was treated as a research problem. Even more interesting was that this research positioned the avid learner at the heart of designing a pedagogy to teach computer literacy.

In Allen's notes on his 2013 lecture *The Backstory of the 1980s BBC Computer Literacy Initiative*[26]*,* he said "There wasn't a British machine that matched up to our ideas of what was needed in a personal computer … [and] after a good deal of thought it was decided to produce a new machine as the BBC microcomputer." The specification was drawn up by BBC engineers and sent out to small British companies operating in the fledging market for 'micro' computers. A small company called Acorn was awarded the contract. This machine was an example of stabilisation of hardware and operating system software, a continuation of the stabilisations described in Chapter 4. Critically, the architecture was open, which meant that it could be used to drive other digital devices and the user could invent new applications ((Naughton 2012). Moreover, it was marketed at an affordable price and supported by software and books aimed at the "self-directed learning market" (Radcliffe & Salkeld, 1980, p.50).

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[26] Lecture at the National Museum of Computing 14th November 2013 (Notes)

THE BOOK KEEPER
THE COOK
THE CHILD-MINDER
THE GARDNER
THE TEACHER
THE SECRETARY

Addresses the learner, individual, self-help with frequent use of 'you can'

Costs less than the average video £399

Network extents to retailers "Buy from WH Smith, Boots, John Lewis and Local Acorn stockists."

Advertising archive online UK, printed with kind permission

Accessed via advertising archive 12 April 2014

Figure 5.4   Advertising The BBC Micorcomputer System Personal Computer (circa 1984).

When the microcomputer was switched on, the user saw the word 'BASIC' and a flashing cursor, and the machine waited for instructions in the BASIC programming language. The machine had achieved a stable state but it was just one node in a network.

The discourse of 'personalised learning', and 'flexibility' in the TEL call documents (2006, 2007), as well as the emphasis on 'user engagement' and 'dissemination', can be traced to the network associated with the CLP. The network connected the BBC Micro (the machine), the BBC series, the network of alliances forged by the BBC *Continuing Education Television*, and the counter culture discourse of individual agency. The effect of this was the construction of the '*learner'* and *'learning'* in ways that is still associated with TEL research.

This discourse of self-help and individual agency, worked in a number of ways, some of which appeal to desire, seduction and empowerment. These are illustrated in the following three examples.

In the first example the BBC Micro and learning are bundled together as a desirable package. The 1980 advertising campaign for the BBC Microcomputer System marketed the machine as the ultimate home help (the bookkeeper, cook, child minder, gardener, teacher and secretary). In contrast to the 'machine as mind' discourse, this advertisement appeals to the self-help reader and speaks the language of empowering the buyer. The advertisement is selling the machine as something that can be learnt as well as the materials to learn how to make the machine do things (Figure 5.4).

Notably, the advertisement speaks directly to the person. Referring to the images of what the computer can do, the text reads: "Above are just some of the ways you could use the BBC Microcomputer. And we say 'you' advisedly. For contrary to misconceptions…", it goes on to spell out how anybody can learn 'computers', that learning is supported by software, manuals and lessons, and that there is network of organised activities. The person is invited to become 'better', to 'know more', to be more 'modern', and to keep up with the children! The advertisement persuades the reader that they are learners, and that this is possible by buying into 'self-help learning'. This discourse of self-help speaks of a community of like-minded enthusiasts who support each other. In the time-honoured tradition of continuing adult education in the UK, the prospect of friendship and romance was in the offering.

Screen captures from BBC series: 'Making the most of the Micro'; 'The Computer Program'; and 'Micro Live'. The images are from across the three series from 1980 to 1987

Figure 5.5   Images from the BBC series: 'Making the most of the Micro'.

Advertisements in the 'Micro User' magazine were wide ranging and placed alongside the fun competitions with prizes like a gold plated BBC (*Micro user* magazine April 1985).

The second example is about the pedagogy of persuasion. The series and the computer were separate operations, although it is unlikely that either project would have been actualised without the other. The first of the BBC series, *The Computer Programme*, was broadcast in 1982; the second series, *Making the Most of the Micro*, in 1983; and the third, *Micro Live*, in 1984/5. The CLP team recognised that viewers could not learn about computing by watching television programmes alone. They concluded that learning had to be practical 'hands on'. Viewers needed to be inspired to invest in the computer and motivated to work out problems that could be solved by programming computers. To illustrate how this discourse works I describe the persuasive power of combining pedagogy with broadcast media.

Each episode is organised like a lesson starting with a 'hook'. For example episode 8 is about Artificial Intelligence, and the first scene opens with the presenter struggling

with a rubrics cube accompanied by clicking and crunching sounds. This is followed by the presenter talking directly to the audience:

Script "this must be just about the most maddening puzzle ever invented. Just as you think you have got it correct you notice another little square that is slightly out of place. Just the kind of problem you would think the computer would be good as solving, and it is except for one thing. Somebody has tell it how to go about finding a solution. What we are really waiting for is the kind of computer to which you can give a problem and then leave it to work out the answer all by itself. Just the kind of thing science fiction is about. The thinking machine. "

In one minute the presenter both illustrates and introduces the topic. The episode features a robotic dog in a maze and a dialogue between two presenters one asking naive questions and the other taking on the role of teacher. Many of the explanation forms are pedagogical techniques such as questions and answers, metaphors, examples, humour, demonstration and invitations to 'have a go'.

The visual design of the set is functional, focused on explaining the complex content, but also invokes inner world beyond the screen. Images from the series in Figure 5.5 illustrates how learning as persuasion is enacted so that the 'learner' is enrolled into intimate collaborative activity. The frames are visually intimate, they focus on small groups, two people and often just one person absorbed in a task.

There is an intimate relationship between the computer, the task and the people. It could be a small group seminar or a private tutorial or mentor instructing a learner. In some ways the series is like an adult education course, rather than primetime entertainment. There are many slow-paced shots of one individual absorbed with some activity on the computer screen or devices controlled by the computer, or two people deep in conversation with a third presence of a computer or other digital device. Yet pedagogy, knowledge, problem solving and learning are the ingredients of the entertainment. The studio recreates a functional laboratory environment with something of the glamor of espionage and edgy new knowledge.

Making the most of the Micro. Episode 'THE Versatile Machine'. Broadcast 10 January 1983.

The episode opens with the title and a lot of carriage returns, bleeps and other machine noises. The screen begins to 'talk' with the text "My name is Richard Gom," The presenter cuts in with information "Richard Gom suffers from Cerebral Palsy, he can't speak he can't walk, his limb movements are unpredictable, but he can control the movement of his head. His disabilities have not prevented him from persuading an academic career. He studied for a PhD in philosophy at Swansea and it was the agony of writing a long philosophy dissertation on a typewriter that first led him to consider how a computer could help him."

Data from collection 2 on the Computer Literacy Project and the BBC series 'Making the most of the Micro'

Figure 5.6   'The Versatile Machine' footage from BBC broadcast (1983)

The third example is about constructing the empowered individual that has 'learned computing'. Blyth (2012) writes: "The BBC Computer Literacy Project (CLP) came out of the BBC's *Continuing Education Television* Department. Based in Villiers House, the department was colloquially known as 'the place for people with ideas above their station' due to the number of bright young things working in a grey office block positioned over the railway line at Ealing Broadway"(p. 9). This was a generation that came of age in the 1960s, which is relevant because ideas and practices in education in the 1960s were moving towards more informal, person-centred, individualised pedagogies. The Plowden Report (1967) was very much a product of its time starting with the famous words, "At the heart of the educational process is the child" (Plowden 1967, p. 7). But this report was not just about children and compulsory education, it was also about opportunities and the individualisation of teaching and learning. (Gillard et al. 2009). This counter culture discourse of liberation through technology was described earlier, what is relevant here is the heightened consciousness amongst educated young people, not only of their individuality and agency but also their responsibility to society. How were these tendencies manifested in Broadcast media; and how the empowered individual learner was *constructed* through the *Computer Literacy Project*?

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One way in which this discourse worked was by individualising the audience, by inventing ways for the audience to participate. Audience participation is such a taken-for-granted feature of modern media, that it is difficult to image a time when audiences were passive viewers, when getting involved meant writing a letter and then waiting for a response. The CLP and the series invited and invented new forms of audience participation, by incorporated stories and problems in regular featured items that were designed to speak to the individual: 'tell us your solution to this problem', 'write to us about a problem you want solved', 'tell us … for a trip to the studio'. A variety of audience stories were included in the series and the related publications.

An example of this is the story of a PhD student with cerebral palsy who first used the Micro to write his thesis, then went on to program his computer to control the devices in his house (Figure 5.6). Another example is of the a music enthusiast who wrote a programme to do his own mixing. These are stories of personalising the machine, finding flexible ways of using the machine, being more productive, more organised and being able to do things that were difficult or impossible without the Acorn computer.

Widening the account, it is possible to identify new forms of authorisation and legitimacy from the various relations that have been described. Technology, learning, enhancement, and TEL research forged new relations beyond academic research and developed informal networks of learning that connected with formal institutions. The alliances were successful in enrolling the public. For example, one designer of the BBC Micro, Steve Furber from Acorn computers, was scheduled to give a technical talk at the Institute of Electrical Engineers. He recalls (quoted in Blyth 2012):

> The first sense I got that this thing might exceed our wildest dreams was when we were lined up to give a seminar at the (then) IEE Savoy Place in 1982. The main lecture theatre seats several hundred, but three times the capacity turned up. Coach-loads of people had come some distance, for example from Birmingham, to hear about the BBC Micro. A lot had to be sent away to avoid exceeding the safe capacity of the lecture theatre. We were booked to give the

seminar two more times (and many other times around the UK and Ireland just to meet demand. (p. 18)

This rock star mass appeal was one indicator of success. Another was the audience viewing figures, and correspondence records. Over a quarter of a million viewers were watching each TV transmission on Sunday mornings and Monday afternoons, with the late night transmission gaining nearly one million views. Broadcasting Support Services were responding to over 2,000 letters a week (Radcliffe & Salkeld 1983, pp. 30–31). Yet another indicator is the demand for the BBC Micro itself. In January 1982, 1,000 machines were manufactured, increasing to 2,500 in February and 5,000 in March, yet in April there was still a backlog of orders exceeding 20,000 (Blyth 2012, p. 35).

The audience for the CLP was self-selected enthusiasts, and the market for the BBC Micro Acorn Computer was the home user. The self-help material was designed for these audiences. While these observation are specific to the archives, in retrospect there are some indications that the self-help rhetoric evident from the data was part of other changes in relation to construction and practices of 'learning'. One is the rise in enrolments into taught courses relating to computing and computers. For example, between 1979 and the end of the 1980 there was a steady rise in the number of students studying computer related courses at University and adults subscribing to computer courses (ibid. pp. 38–44). Furthermore this was entangled in complex ways to theories and practices of education in the 1970s and 1980s. This is evident in the wider literature on adult education which emphasised self-directed and computer based learning with students working through material at their own pace (Brookfield 1985; Garrison 1987; Robertson 2005). Another separate, but related, change was the economic effects of government supported enterprise. Individuals who did the research and learnt how to solve the problems involved in developing, manufacturing and distributing the BBC Micro Acorn had what Blyth describes as a profound effect on the success of the Cambridge high-tech cluster: "Local venture capital firms played a major role in supporting fledgling start-ups. But the motivations, trust and cooperation of entrepreneurs are built around the social networks developed over decades" (ibid. p. 53).

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Returning to the question of *What is TEL research?* and *Where does it come from?* there are some indications that the discourse regularities of quantification, and accountability (in the TEL call documents) have some antecedence in the history of the BBC Micro Acorn Computer and the BBC CLP. The TEL call documents (2006, 2007) invited researchers to develop something like the same impact, visibility and reach that emerged when a network of energies and resources came together so that constructions of learning and technology changed. But the translation of this complex history, in the TEL call documents (2006, 2007), ignores the painstaking, difficult and time consuming process of forming alliances and building productive networks. Instead it fast forwards to auditable targets (e.g. measurement of participation and impact). This can be understood as reducing the success of the CLP and the BBC Mico to a chain of cause and effect procedures for change management.

Concerns about opacity of modern computers and the proliferation of digital goods as consumer appliances has prompted some nostalgia for the BBC CLP (Naughton 2012). There are claims that in the 1980s the possibility of being able to learn programming was tied to the computers that were open to programming by anybody that was interested. Although the BBC Micro is often regarded as an educational machine, as indicated earlier the target market was home computing. Successive generations of policy makers and TEL researchers are more familiar with "preprogramed devices with no user-modifiable components. And since the Americans were better at producing such appliances than the Brits – and have a huge internal market to play with – the BBC Micro was a bit of a dead end, industrially speaking" (Naughton 2012, p. 1). Acorn Limited was simply beaten by its commercial rivals from the US, in particular Apple and Microsoft, and in 1998 it was broken into several independent operations. Other agencies entered the affray.

The BBC was scolded by regulators for stepping outside competition boundaries in chasing technological innovation and audiences(Briggs 1995). During the 1970s, and throughout the Thatcher years, the BBC existed in a state of more or less permanent crisis (Seaton 2015). Not surprisingly, in one of the many restructures during this time, *Continuing Education Television* was disbanded. In the wake of these controversies and the publication of some influential reports (Kennedy 1997;

Dearing 1997; Tomlinson 1996), the discourse of learning shifted towards more formalised quantifiable types of learning. In other words, assessment and accreditation came to be relied upon to demonstrate that learning had taken place.

This section has argued that for a short time during 1980s, the discourse of learning was about participation and active learning, learners were self-selecting in their relations with technology and the technology was open to instruction (Blyth 2012b). Running in parallel the next section is about how the discourse shifted towards what could be audited and documented, and computers were commodified as controlled appliances.

Business: (the 'e-learning' providers)

The second network is the business-to-business industry of e-learning providers, products and services. This industry problematises the effectiveness of training in the business world and promotes technological solutions to address this problem. On the first page of the TEL call document (2007), TEL research is described as a rebranding of e-learning. Before 1997 there was no such thing as e-learning. What changed is that the network of TEL research was taken up by another network from the world of business. Their network that was in the business of providing learning to workers.

In the world of business in the 1990s, the term learning (rather than education or training) was used to quantify 'output' from investments in development of human capital (Wright & McMahan, 1992). Industry depended on workers' capacity to learn, and this needed investment and auditing for calculating return on investment. 'Learning' in the business sense is a lucrative business to business service. This is because company employees, customers, suppliers, distributors, investors and business partners all need ongoing access to learning.

> The meme of learning was replacing training. Training is something trainers push to trainees. Learning is whatever gets past their personal firewalls (AKA skulls) [sic] and lodges in the brain. I can learn something; you can't learn me something. A big part of the sales pitch for early versions of web-supported

learning was the elimination of costly trainers. You couldn't very well call this training. (Cross 2008, p. 1)

In this network outside of government-funded research and the academy, the prefix 'e' entered business terminology in 1997 as a marketing term for digital technology. In the same year Pierre Omidyar founded eBay, eCommerce was used as a term to buy things online and eBusiness followed as a catch all. Notably, e-mail become email and there was talk of e-zines and e-books. Even before the web there was EDI (electronic data interchange) and EFT (electronic funds transfer) (Cross 2008).

Digital technologies were affecting business practices in other ways (Galagan 2000). As companies became larger and more global, freedom from time and location constraints became a business goal. Companies like SmartForce began marketing Computer Based Training Systems (CBT) as an alternative to classroom-based training for their workforce (Macromedia Inc. 2003). Commercial training providers then launched an *e-learning* public relations campaign to reach out to entrepreneurs, business and industry, governments, and policy makers. In 2002 SkillSoft Corporation (Nasdaq[27]: SKIL) and SmartForce (Nasdaq: SMTF) announced the merger of the two companies with the bold claim that the combined company will be leading provider of e-Learning solutions to the Global 5000. This is interesting because business practices began to mobilise e-learning as part of the business discourses of efficiency and maximization of profit. This is evident in the marketing of 'online synchronous learning', and 'flexible online access to learning', not just as new channels of communication but as solutions to the problem of effective learning. Once e-learning was established as a network with affiliated groups in many parts of the world, e-learning research became TEL research. How did 'learning' become a business problem/solution and a marketing project? To explore this I examine statements from publications and organisations around which this network circulates.

In the late 1990s Bizmedia Ltd., a multi-media publishing company, expanded its publication empire by positioning 'Learning and Development' as one of its target sectors alongside 'Information' and 'Financial and Professional'.

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[27] National Association of Securities Dealers Automated Quotation – Index that locates the value of a public company
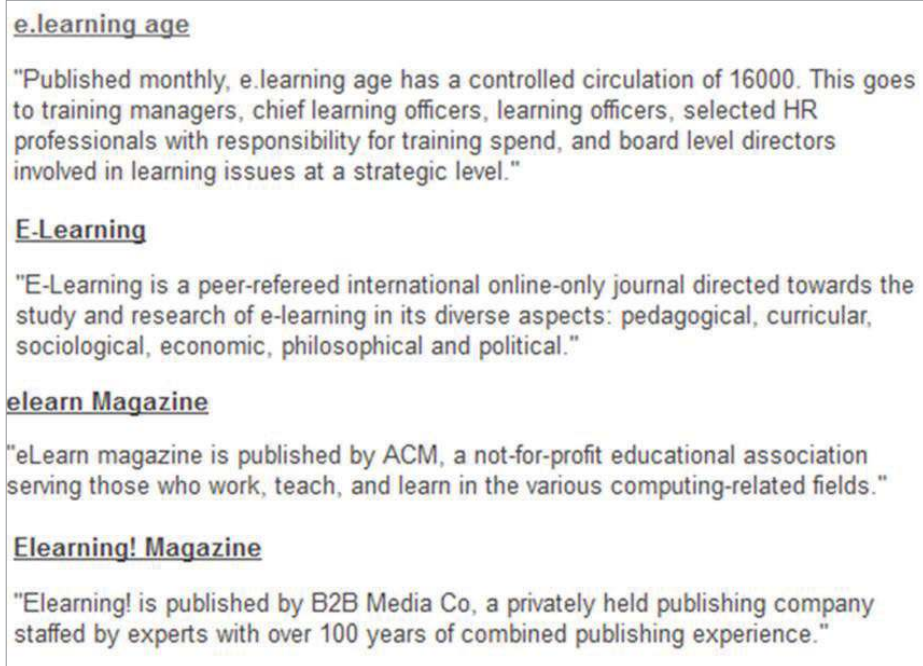
By 2002 e-learning became the preferred term to describe TEL in the commercial training
publications, in peer reviewed journals and in the not for profit educational associations. (Archive
www.archive.e-learningcentre.co.uk viewed 16 November 2015)

Figure 5.7   'e-learning' representations in commercial training publications (circa 1996)

In 2001 Bizmedia Ltd. launched *e.learning age*, a trade magazine that promotes
media products and services to business to business markets, and also claims to
provide the latest in research and analysis.

Following various marketing campaigns other TEL networks adopted the term e-
learning (Figure 5.7). This is demonstrated in statements from publications that are
directed at the business market but also cross over into academic, peer-reviewed
publications. The marketing campaign promoted e-learning as more than products
and services – it was offered as a way of life so that it became difficult to think of 'e'
or learning in any other way. This discourse works by appeal to desire, reason and
power, and this is illustrated in two examples.

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Subliminal product placement associates a 'fresh' 'young' face with the message of "E-Learning *here & now*".

The vocabulary mixes language from software design (e.g. integrated solution); education (e.g. modular approach, assessment); and business (e.g. streamlines your decision process).

References to white paper are usually published by government departments. Here the white paper stands for claims of expertise, and it is a free download.

The academy is usually associated with sites of scholarship and knowledge. Here the term is appropriated for computer based training on the internet.

Advert from the training trade *magazine e-learning.age* (2002, p.19). The publication changed ownership a number of times during the 1990s and at the turn of the century.

Figure 5.8   Advert from the training trade *magazine e-learning.age* (2002)

In the first example e-learning is offered as the object of desire. Figure 5.8 is an example of advertising in the *e-learning.age* magazine (2002) that invokes more than is verbalised. The attractive face of e-learning is depicted literally; it invites engagement with providers who "speak your language" and make e-learning easy by "slashing implementation and content development time". By having the resources to pay for an advert in the magazine *e.learning.age*, the company advertising e-learning is already authorised to speak about the subject. The company is authorised as leading business providers and this in reiterated in phrases like "world leader", and "partnerships with the world's leading providers". Business connections are given prominence. Bizmedia Ltd. runs network events, conferences and adjudicates over what is described as "The glamorous and exciting E-Learning Awards … acclaimed

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industry standard celebrating e-learning success, highly coveted for their high standards of independent judging" (e-learning age 2002, p. 17). (CloserStill 2014)[28]

In the second example, the construction of e-learning is made persuasive by using the conventions of reasoned argument and suggesting the authority of government and academic research. Companies adopted academic sounding titles such as 'The Internet Academy', and marketing materials that appropriated the language of government publications, for example, 'The White Paper' (Figure 5.8). Authors of the articles are authorised by their status as consultants to business, and the text is legitimised by connecting claims about e-learning to knowledge produced in established networks both creative and scientific:

> Extracts form *e.learning.age* magazine 2002:
>
> "Our highly experienced, professional team provides innovative solutions in print and online. Other products for the industry include highly valued research and bespoke events.": (front cover)
>
> Mike Mulvihill, managing director, First Creative. "In the global marketplace of finance and industry, e-learning providers are the virtual teachers of the future. The e-learning market is a stage where the most forward thinking of its contributors are maximising the synergies between the electronics and the human brain." (pp. 28 -30). References Steven Spielberg and Stanley Kubrick

Notice how the 'synergy between the electronics and the brain' and 'virtual teachers' is linked to film directors Steven Spielberg and Stanley Kubrick, References to the film industry resonate with elements of the fantasmatic described in Chapter 4. E-learning has no direct connection with the creative industries and is not science fiction, but the comparison work by suggestion.

Another strategy for claiming authority is to adopt the conventions of academic journals by substantiating the main claim with reference to prior research in statements like this from the e-learning.age (2002)

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[28] Press release 13th November 2014 "CloserStill, organiser of Europe's leading L&D event, Learning Technologies and Learning & Skills, has announced that it has acquired Bizmedia Ltd, organiser of the E-Learning Awards and publisher of e.learning age."

Richard Naish, business psychologist specialising in e-learning. "Remember that drop-off rates aren't necessarily a bad thing; the learner may have learnt enough from the programme without having to complete it. Unlike traditional training, they don't have to sit in a classroom bored and frustrated …. (p. 19). References Tharenou, P. (2001) The relationship of training motivation to participation in training and development. Journal of Occupational and Organisational Psychology, 74, 599-621

Even so, if the article referenced by Naish is peer reviewed, the deduction from the referenced source of Tharenou (2001) would almost certainly be contested because this article claims statistical significance when describing the effect of management support on motivating the workforce.

Widening the account, it is clear that connections and partial connections that invoke the authority of academic research has shaped the business discourse of e-learning. However, once the network became powerful the discourse folded back into TEL research, with funded TEL researchers adopting the term e-learning. The discourse of e-learning constructs learning as desirable, seductive, and powerful: a fantasmatic vision of a new world of knowledge. But where is the learning subject in this packaging? If the worker–learner is someone who is employed by a company and engages in professional development, then in the discourse of e-learning the learner is abstracted into a social capital calculation. This is a discourse of improving business systems, and its language and values are couched in terms of efficiency, effectiveness, the customer and profitability. This discourse from business homogenises the research themes and business goals as equivalent, and in the process quantifies constructions of 'learning' and the 'learner'.

One response to my research question *Where does TEL research come from?* is that it comes from the disciplining effects of discourse from beyond the academy. The systems discourse of business goals and solutions works alongside business practices in marketing products and services (including technology and learning). In this way, learning enhancement is enacted as an abstract systems goal and, at the same time a

fantasmatic desirable life-style choice. The effect of this discourse on TEL policy and practice networks is taken up next.

Policy: (evidence based practice)

The third network circulates around the relationship between education research, policy and practice, and by association TEL research. Focusing on the UK, this network consolidates the forces of successive governmental policies, as well as non-departmental public bodies and professional associations. This is a gathering of forces that translated learning by aligning conditions of funding with policy goals and the discourse of evidence-based practice.

In the UK, 1979 marked the election of the Conservative administration led by Margaret Thatcher and the battery of neo-liberal policies that affected industry, commerce and public services, including research and education. According to Jones (2003):

> Conservative legislation sought to drive neo-liberal principles into the heart of public policy. An emphasis on cost reduction, privatization and deregulation … and the promotion of new forms of public management. The outcome of these processes was a form of governance in which market principles were advanced at the same time as central authority was strengthened. (p. 107)

It is not a coincidence that references to cost reduction and central authority were prominent in the discourse of business and e-learning providers. These associations problematised the accountabilities associated with funded research. In the UK this was highlighted in the 1990s when a series of reviews on education research questioned the value and relevance of publications in the field (Goldstein 1998; Hargreaves 1996; Davies 1999). Rhetoric from the United States on comparisons with the success of medicine began to translate the ideals of cost reduction and central management into an assumption that research should be providing proper evidence for implementing policy goals. In the UK this was taken up by the Labour government in 1997 in its proclaimed commitment to evidence-informed policy and evidence-based practice.

This is part of the discourse history of *where TEL research comes from* because the regularities that homogenise goals, makes it possible to bracket TEL research with TEL products, services and marketing events. As a form of truth making, this is possible because of the alliance between sections of the academy, government funding bodies, and those involved in the business of providing e-learning products and services.

An example of this alliance in the UK, is the Joint Information Systems Committee (JISC). This was set up in 1993 to support the business of higher education with respect to TEL policy and practice. JISC is a quango, in other words a non-governmental bodies partly funded by government and authorised with governmental powers but without the accountabilities. JISC was set up with government and business funding to provide information systems, products and services to government businesses concerned with education, skills, information, and ICT infrastructures. An early mission statement says that JISC was set up "to support post-16 and higher education, and research, by providing leadership in the use of information and communications technology (ICT) in learning, teaching, research and administration" (Follett 1993; McCrindle 1999). In 2003 JISC signed agreements with international quasi-government organisations in the Netherlands, Australia, Germany and Denmark. This is interesting because JISC partnerships are not limited to government, industry or the academy. The language of the following eight JISC strategy themes is a heady mixture of enterprise, procurement, business development, applied research and quality assurance of education systems.

1. e-Learning – improves the quality of learning
2. e-Research – technologies used in research
3. e-Resources – digital information and e-content
4. e-Administration – improves administrative processes
5. Access management – secure authentication and authorisation
6. Network – UK research and education network
7. Information environment – convenient access to resources
8. Business and community engagement – knowledge transfer
    (JISC strategy 2007-2009, 2006)

So far I have argued that enterprise and systems constructs connected policy goals and TEL organisations like JISC.

Widening the account the influence of these alliances on the *Where TEL comes from* is significant. The alliances in effect changed *what TEL research is* by changing what it should be doing. This is evident in a series of strategy documents aimed at policy makers and produced by committees of academics (discussed in the next section). Where is the '*learner*', and '*learning*' in this discourse of change and management? As discursive construction, both can be understood as abstractions of economic and social change. The '*learner*' is the worker citizen that needs to be managed, and '*learning*' is the measurement of success or otherwise of this management project.

Compared to the research practices described in Chapter 4, TEL research is being enacted in particular ways that are about workers, productivity and governance. There are controversies of course, for example that technology, rather than pedagogy, is steering TEL research on assessment. There is also controversy around the kinds of agenda that TEL can support, for example, productivity vs. social inclusion. These controversies are couched as scientific and political differences, but the same discourse is evident in that both are advocating change by rational intervention. As in the engineering discourse described in Chapter 4, there is a shared commitment to progress, and beliefs in the 'objectivity' and essential truth of scientific knowledge. The prevailing discourse limits what is possible to imagine or do in the name of TEL research.

Clearly, discourse(s) that I have referred to as being akin to systems management and engineering (see Chapter 4) are powerful and disciplining, but predictably they are also enacted in complex, and sometimes subversive ways. This ambivalence, where coherence and non-coherence are co-present is taken up in Chapter 6.

Academy: (disciplining research)

The fourth network circulates within the academy and in its relations to policy makers and TEL practice outside of academic research. Like many academic

networks, TEL research is authorized by being located in established research groups in institutions of higher education. The most prestigious of these have their own physical locations and access to services such as administration and technical support (*Evaluation of the Technology Enhanced Learning Programme* 2015). When an institution has a history of securing competitive funding from prestigious funding organisations (in the UK this is ESRC and EPSRC), these resources make it possible for research groups to secure further funding and present coherent public accounts of what they do (Nuyens 2005; Rees et al. 2007). TEL research centres like these are organised around funding cycles, and its employees are on contracts that are reviewed according to their performance in attracting funding as. This can be seen in many guides including *Research Contracts A Researcher's Guide* (Roland, 2003)

Research centres like London Knowledge Laboratory are the establishment face of TEL research in the UK[29]. On its website it is stated that the centre brings together "computer and social scientists from a very broad range of fields" followed by a list which includes: education, sociology, culture and media, semiotics, computational intelligence, information management, personalisation, semantic web and ubiquitous technologies. An accompanying statement is that this diversity means that issues are tackled from many different perspectives. The site states that "The ways in which we learn, and what we need to know, are changing" and there is an emphasis on the relevance and usefulness of TEL research – in other words utility. This can be understood as problematising the future of 'learning' and the 'learner' and at the same time foregrounding utilitarian research.

In this chapter, the section on *Policy: (evidence based practice)* described some partial connection to discourse from outside the academy, and *where TEL research comes from*, and argued that this has a disciplining effect on the constructions of TEL research. However, this was not simply a hostile takeover, or any such obvious exercise of power. Nicoll (2008) captures this in her selection of a quotation from Foucault:

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[29] http://www.lkl.ac.uk/ London Knowledge Lab viewed 16 November 2015

[The] chief function of the disciplinary power is to 'train', rather than to select and to levy; or, no doubt, to train in order to levy and select all the more … Discipline 'makes' individuals; it is the specific techniques of a power that regards individuals both as objects and as instruments of its exercise. (Foucault 1977, p. 170, quoted in Nicoll 2008, p. 167)

To be a funded TEL researcher, employed in a centre for TEL research, TEL researchers are willing subjects in constructing their TEL research into particular kinds of coherence. But what form does this coherence take and where does it come from? More specifically what effect does this have on constructions of 'learning' and the 'learner'?

Before the terms TEL research or e-learning were in use, technology, learning and enhancement were recurring themes in work from researchers in fields that drew on both computer science and cognitive science. These fields included, for example, Human Computer Interaction (HCI), Computer Supported Collaborative Work (CSCW), Computer Supported Collaborative Learning (CSCL), and Artificial Intelligence (AI). This is one lineage of *where TEL research comes from*. In these fields, TEL research is constructed as applied research that implements principles from foundational disciplines (see Chapter 4). Towards the end of the 1970s cognitive science had coalesced as a discipline around two assertions. The first assertion was about "the representational theory of the mind, and the thesis that human behavior and experience can be explained by explicit mental structures and operations" (Carroll, 2003, p. 3). The second assertion held that "effective multi-disciplinary science should be capable of supporting and benefitting from application to real problems" (Carroll, 2003, p. 3). Cognitive science discourse is based on the foundational ontology that knowledge about learning can be discovered and represented as objective truths. Based on these assertions applying principles from basic research to real world problems is regarded modus operandi of science common sense (ibid.).

For example, Card, Moran and Newell (1983), in their classic text, *The Psychology of Human Computer Interaction*, introduce Goals, Operators, Methods and Selection

rules (GOMS) to draw on general principles of perception, motor activity, problem solving and language, communication and group behaviour to model predictable human–computer interactions. This is recognisable as de(re)construction from the discourse of engineering; in the case of GOMS the technique is applied to the design of software to enhance human performance (see Chapter 4).

Contemporary accounts of TEL are less emphatic, but nevertheless the relationship between foundational understandings and applications to solve pressing 'problems' is implicit in the realist ontology of drawing together many perspectives on common 'problems'. This is the position adopted by the London Knowledge Lab (described earlier).

In the 1980s, TEL research (not by that name) was one of the fields that in Carroll's (2003) generous reading "encompassed nearly all social and behavioral sciences" (p. 5). Carroll's history describes the differences in ontological commitments between researchers like Brodker (1999), Engestorm (1987), Suchman (1987), and Wanger (1987). But then describes differences as complementary perspectives (Carroll 2003). Invoking perspectives is interesting when translating conflicting ontologies as *different but same*. Technically, ontological differences are not perspectives on the same reality, but they are different conceptions of the real. This *same but different* claim is evident on the London Knowledge Lab website. As described earlier there is a list of fields (background) of researchers employed at the research centre, followed by the claim that "issues can be tackled from many different perspectives". This effectively homogenises differences as perspectives on the same 'realist' research problems.

In contemporary accounts of TEL research the language of 'perspectives' and 'applied research' is more or less taken-for-granted, while the imperative to demonstrate coherence was taken up actively by TEL researchers. TEL researchers were given the task of taming troublesome fragmented bodies of TEL knowledge (*The Becta Review Evidence of progress of ICT in education* 2006). To demonstrate coherence, accounts of TEL research need to present findings in a form that suggests self-evident utility.

Theories	Approach	Main characteristics	Potential e-learning applications
Behaviourist	• Behaviourism • Instructional design • Intelligent tutoring • Didactic • Training needs analysis	• Focuses on behaviour modification via stimulus-response pairs, controlled and adaptive response and observable outcomes • Trial and error learning • Learning through association and reinforcement	• Much of current e-learning development represents little more than transfer of didactic approaches online, the 'web page turning mentality' linked directly to assessment and feedback
Cognitive	• Reflective practitioner • Learner-centred	• Focus on internal cognitive structures; views learning as transformations in these cognitive structures • Pedagogical focus is on the processing and transmission of information through communication, explanation, recombination, contrast, inference and problem solving • Useful for designing sequences of conceptual material that build on existing information structures	• Salomon's notion of distributed cognition (Salomon, 1993) could lead to a more shared knowledge structure between individual and surrounding information-rich environment of resources and contacts • Development of intelligent and learning systems, and the notion of developmental personalised agents

An example of coherence making illustrating decomposition and mapping as techniques of knowledge construction.

Figure 5.9   An example of constructing 'knowledge' by mapping.

Guidelines, recommendations, heuristics, principles, overview maps are typically associated with utility. But this is not enough. This has to be authoritative and valid, knowledge worthy of representing TEL research alongside other prestigious applied fields. This is demonstrated in two examples.

The first example illustrates a form of truth making by association. Figure 5.9 illustrates a set of mappings. Categories of learning theories are positioned alongside categories of e-learning applications in a table. The sequence of statements is an arrangement of labels, names, and associations that are complex categories, and as a form of enacting utility, these complex categories are treated as self-evident truths. In the first column the label 'Theories', names two large categories 'Behaviourism' and 'Cognitive'. In the rest of the table there are many other: cognitive constructivism, social constructivism, experiential, activity-based and situated learning. These categories are then associated with labels that are 'Approaches' to teaching and learning.

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(Conole and Oliver, 2007: 6)
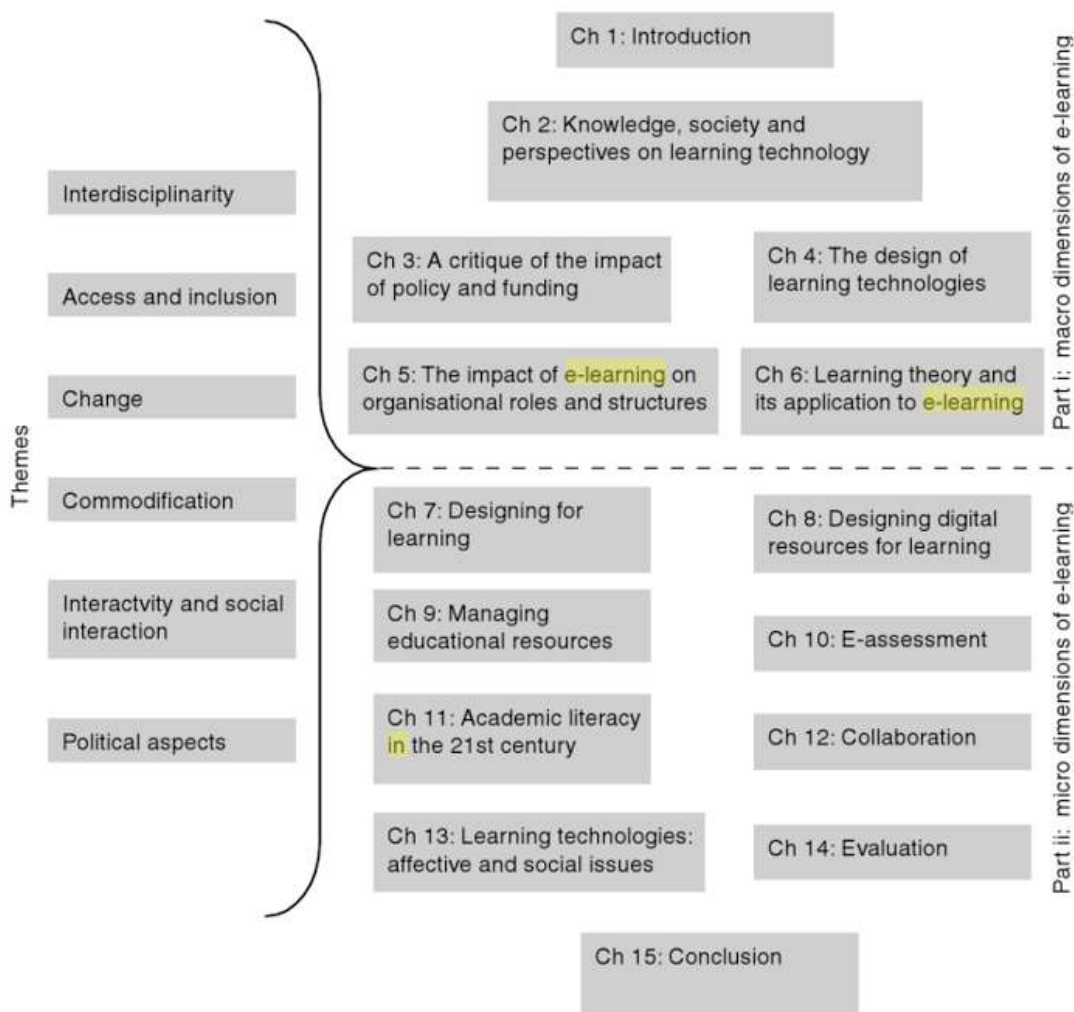
Structure of the book and cross cutting themes that suggests a consensual synthesis of the field of TEL research

Figure 5.10 An example of asserting a framework to construct synthesis.

There is further work involved in translating statements about theories of learning into design statements that can help engineers build educational technology. These are offered as an "illustration of design principles that can be distilled from a range of psychological, social and educational literatures" (Fowler & Mayes 2000, p. 47). Utility is invoked in the form of guidance and relevance, and truth is asserted by the breath of the analysis and the authority of the research group. These forms of

aggregation and analytical cumulation are authorised by the medical science literature on meta-analysis (Thomas & Harden, 2008). This enacts utility while being distant from teaching and learning and development of TEL technologies. Interestingly, this is an example of TEL research that is called a 'desk study'.

The second example comes from an edited volume of TEL research in which 50 contributors from many different disciplines, countries and organisations worked on a joint vision of TEL research: *Contemporary perspectives in E-Learning research,* edited by Conole and Oliver (2007). In this text, the field of TEL is organised so that everyone could be accommodated. Policy, learning theory, technology design, and organisational change are separated and described as macro in contrast to parts of the book covering micro topics, for example, E-assessment (Figure 5.10). Utility is pragmatically packaged as 'TEL themes, methods and impact on practice'. The value of this work is evident in making TEL research visible and accessible. It is authorised by the status of the contributors. The publication is positioned as an overview for policy makers and new practitioners. In the process of achieving this, controversy is domesticated and there is no reference to discourse materialised in digital technology. There is also overt simplification: for example, Foucault is misrepresented by the statement "New technologies present new Foucauldian means by which those with power can secure greater knowledge and control over others" (p. 51).

Frameworks, and models can be understood as textual and visual devices for making coherence as in Figure 5.10 the structure of the book works to fit in, and accommodate things that are quite different. The effect this 'coherence' making, is that it is possible to make certain assertions into factual truth claims, for example:

> E-learning has become mainstream and the field of learning technology is beginning to stabilize as a profession … The hallmark of a profession includes both a codified body of practices (embodied knowledge including competence) and abstract knowledge in the form of theory (Jones & Czerniewicz2011, p. 173).

Once again this is an association with the prestigious professions of medicine and law. What is being claimed is that TEL is also 'an applied field' similar to medicine. Medicine is accepted as a knowledge-based occupation in which the work of practising professionals (e.g. medical doctors) is underpinned and informed by abstract knowledge (e.g. medical research) and practising medical doctors may also be researchers (Macdonald 1996).

The work involved in inscribing coherence is significant, and it has had significant implications for TEL as a field of inquiry. Making 'coherence', mobilises forms of 'truth making' that enrolls wide-ranging things, including knowledge conventions from different disciplines, and the subjectivities of TEL researchers.

Widening the discussion, the accommodation of many possible construction of learning can be understood as a form of accommodation and alliance making. The discourse circulate around the rhetoric of TEL as applied research and different TEL practices as perspectives on the same reality. This goes some way to explaining why in the TEL call for funding documents (2006, 2007) accountabilities are opaque. Alongside this opening of new possibilities, the imperative to utility and coherence has been normalised by leading TEL researchers (Conole & Oliver 2007). Increasingly this means framing accountabilities in utilitarian terms so that TEL research is translated into what is possible to communicate to non-technical audiences. In practice, the work of making coherence is performative in mobilising a mesh-up of things human, material and semiotic. At the same time the imperative to produce coherence and utility is limiting what is possible to think and do, and publish in the name of TEL research.

DATA SOURCES AND ANALYSIS

SHAPE OF THE ANALYSIS

①

Vantage point : TEL call documents

②

③

Policy discourse
TEL research is a Policy instrument for education change. 'Learning' is e.g. social cohesion , and productive workers

Business discourse
TEL research is about products and services for commercial competitive advantage. 'Learning is a business asset'.

Media discourse
TEL researchers are required to validate their work demonstrating audience impact and engagement. 'Learning' is audience driven.

Homogenizing of research here 'differences are subject to treatment' which works to normalize the disciplining effects of discourse from beyond the academy.

Quantification works by adopting constructs and language from policy and business that can be traced to the narratives of progress, objectification and essentialism

Opaque accountabilities works by enrolling TEL researcher as willing subjects to enact the other regularities for the greater 'good', while leaving open what this is.

⑥

TEL research makes coherence for policy and practice audiences.

Discourse materialised in the machine is invisible

The learner and learning are variably revered and romanticised, and at the same time objectified abstractions

Where is mess?

Collections 2 and 3

Translations networks

④

⑤

Broadcast media example entities

BBC micro
Primetime Episodes
Continuing Education - Department BBC
Acorn Ltd.
Adverts
Learning Guides
Micro Magazine
Lecture tours
Studio

E-Learning network example entities

E-learning providers platforms
E.Learning.Age Magazine
Computer-based –training packages
Quasi academic publications
Gurus
Cost-benefit analysis
E-publications
Events

Policy and practice network example entities

Website
Evidence
Cost savings
Productivity
Policy documents
Systems Engineering
Mission statements
Grand Challenge
Quango
E-learning, e-resources, e-administration

A schematic view of chapter 5 illustrating regularities, networks, entities and TEL research as coherence for policy and practice

Figure 5.11   Relationship between data, and sequence of the analysis in Chapter 5.

Mesh-up effects: summary

This chapter has drawn on non-deterministic conceptual resources to assert that change is a discursive translation effect. I have combined Foucauldian discourse analysis, and sensibilities from actor-network theory to trace the constructions of learning outside of the academy. The analysis describes how TEL was first taken up in new networks. It then follows the chains of actions and associations in these new assemblages, and finally traces them back to TEL research in the academy. These are accounts that respond to my research questions: *What is TEL research?* and *Where does it come from?*

The shape of the analysis is set out in Figure 5.11. As with previous chapters, I started from the TEL call documents labelled (2) in Figure 5.11. Analysis at this vantage point characterised three discourses:

- Policy discourse spoke of, for example, 'social cohesion' and the 'productive worker'; and in this learning was a policy instrument for measuring progress.

- Business discourse spoke of, for example, 'products and services', 'competitive advantage', 'customers' and 'profit'; and in this learning was a form of accumulated social capital and a business asset (or liability).

- Media discourse spoke of, for example, 'engagement', 'audience impact', 'communication' and 'edutainment'; and in this learning was audience driven both seducing stakeholders and the public and giving them what they want.

Within the text of the Call documents these three constructions of learning were rendered coherent, differences were homogenised, quantified, and buried in opaque accountabilities. This is summarized in Figure 5.11: (3).

The rest of the chapter traced the discourse history of TEL to understand where this came from. Looking back over this chapter, part of *what is TEL research* can be described as a *mesh-up* of 'where it comes from'. Mesh-up is a term used in software engineering to describe new resource created by assembling content from two or more sources in new ways (Bizer et al, 2014). It is an ambivalent term that also implies easy, fast, integration and new coherence, but can also mean intoxication, dysfunction, destruction and mutilation (Turner 2006). Translations of TEL research

discussed in this chapter can be described as enactments of mesh-up. Technically this suggest a grid of different 'power-knowledge' formations, which in their translations effects what TEL research becomes. Through analysis of Collections 2 and 3 (Figure 5.11: (4)), I traced the gathering of things in three networks (Figure 5.11: (5)). The constructions of learning at the vantage point are translations of these mesh-ups.

In the 1970s and 1980s the prominence of the BBC Computer Literacy Project, and the commercial success of the BBC Micro PC (for a time), established learning as a form of self-help personal action appealing to individualism and this perhaps is the discourse history of engaging the public in the TEL call document. After the 1990s the marketing of e-learning, and the establishment of TEL networks with links to business, translated learning into a business process. This perhaps is part of the history of where the quantification of *learning* comes from. In this way, technology enhanced, is enacted as both an abstract systems goal, and a fantasmatic, desirable life style choice. Starting in the 1970s and gathering momentum after 1997, when the Blair government declared its commitment to evidence informed policy, learning was assimilated into a governance discourse. I argued that this is part of the history that constructed TEL research as a means of social reform and systems engineering. This perhaps is part of the lineage of TEL research that homogenies differences, and disciplines TEL researchers to construct utilitarian accountabilities.

In the final section on translating learning, I described how these translations of learning have been taken up by TEL researchers and folded back into enactments of *What TEL research is*. I have argued that the pursuit of coherence and objectification of 'relevance' and 'quality' has led to a narrowing of activity. In particular there is a fixation with categories and abstractions that imitate engineering and medicine. These insights are noted in Figure 4.1 (6).

In some examples TEL research can be understood as a form of knowledge consultancy. At the risk of romanticising the past, arguably this is very different from the discourse history of TEL technology described in Chapter 4, or the BBC Computer Literacy Project described earlier in this chapter. In those accounts it was

possible to write the researcher as the learner, and describe learners, in places of learning, as enrolled in construction and discovery. Alongside this narrowing there are other regularities in the appeal to desire, legitimacy and authority. Accounts of TEL research (in Collections 2 and 3) are entangled in technologies of public relations, marketing, social media and in discourse formations that glamorise and idealise learners and academics. At corporate events, and in gigabits of multi-media on the internet, learners are represented by images of hope and agency, while academic publications, textbooks, practitioner guides and policy reports tend towards disembodying the '*learner*' and quantifying '*learning*'.

The opening quote to this chapter is a reminder of the non-deterministic resources that inform this thesis, and I have arrived at these conclusions on *What TEL is? and Where it comes from?* by tracing various trajectories of translation that are in the business of making coherence. In the next chapter, I show that these translations are partial connections, and that coherence without non-coherence is an illusion.

Chapter Six: Forms of ordering

Practices that generate purity effects are also non-coherent. Let's emphasise this again: we are saying that they are non-coherent, not in-coherent. 'Incoherence' is a normative label, a term of opprobrium, a way of talking about failed coherences. But this is not what we're saying. Quite differently, we're suggesting that different 'logics' are always at hand: not that this is a bad. Or, to put it differently, we're saying that the world, even the 'modern world', is fuzzy and that it always has been. (Law et al. 2014, p. 8)

Introduction: 'enhancement' in TEL Research

This chapter is about how 'enhancement' works in the discourse history of TEL research. The use of the term 'enhancement' and the phrase 'TEL research' was a particular UK and European phenomena from 2006 to 2014. In this chapter I focus on the contemporary history of struggles over what counts as good TEL research, and I do this by examining enactments of coherence and non-coherence in relation to 'enhancement'.

Chapter 4 explored the effects of engineering discourses materialised in digital technology and how this influenced ideas about human machine relations and intelligence. Chapter 5 described how very different discourses from mass media, business, policy, academic research are homogenised; and the term mesh-up was used to describe these practices. What became apparent from this examination is that 'technology', and 'learning' are socio-material constructions with a discourse history that is a complex web of interests, negotiations, successes and defeats. It is clear that, on the one hand, such a thing as TEL research exists: "TEL is a UK £12m ESRC/EPSRC funded programme running from 2007-2012 led by Professor Richard Noss at the London Knowledge Lab" (tel.ac.uk, 2014). This means that the discourse history of where this came from is one response to the question *What is TEL research?*. On the other hand, the discourses of TEL research are neither unified nor stationary, so the question *What is TEL research?* is also about how differences are managed and regulated.

The problem is that empirically, TEL research manifests as both discourse (e.g. engineering and mesh-up) and contingent practices (escaping the discourse of engineering and mesh-up). Law (2004, 2013) describes this phenomenon as the simultaneous performativity of coherence and non-coherence and argues that all practices are the same in this respect (see Chapter 3). Law uses terms like 'mess' or 'messy' as a vivid but technical description of this phenomenon (Law 2004). This chapter is about *forms of ordering* that make action possible when the world is messy. About forms of ordering Law (2000) writes "In the context of classical theory they are closest to Foucault's notion of discourse. This is because they are arrangements with a pattern and their own logic, except, as I have already noted, they are smaller." (p. 22). This means that forms of ordering are like discourse regularities only more tactical and knowing about non-coherence (Law 2004) and this will be demonstrated in the main sections of this chapter.

The first section of this chapter begins by setting the scene with a reminder of how the collections are organised, and how non-deterministic inquiry recognises that discourse is not only powerful and pervasive, but also messy. The remaining four sections of the chapter are:

- *Collections 4 and 5: Inventing the future*. This introduces Collections 4 and 5 and a rationale for how the data is organised, and the selection of data that is analysed and presented in composite accounts and statements.

- *A vantage point: 'enhancement' in TEL research*. This section examines the discourse of 'enhancement' evident in statements in the TEL call for funding documents (2006, 2008), and how coherence and non-coherence are enacted from this vantage point. Based on this analysis, I characterise 'translation', 'rational narrative', and 'separation' as three regularities that are active in accommodating mess.

- *Forms of ordering.* This is the main section of this chapter and it demonstrates the performativity of TEL research and how these regularities are active in four different forms of ordering, which are described as:

knowing denial, persuasive packaging, domesticating rituals, and crafting conflict.

- *TEL research as non-coherent practices: a summary.* The chapter ends with a summary of TEL research as non-coherent practices regulated by forms of ordering that enact coherence, and in doing so opens up the question of why it matters. Answering this question is taken up in Chapter 7.

Setting the scene

Chapter 3 (on methodology) demonstrated that TEL research can be usefully organised into collections characterised by historical interruptions. To do this I worked with conceptual resources from Latour (2004), Law (2005) and Foucault (2002).

Chapter 4 focused on 'technology' and Collection 1. Starting with experiments in engineering facilities, I described science fiction beginning of the machines that 'think', early demonstrations of human computer interaction, and how the physical infrastructure and digital machines stabilised to make realities that are difficult to undo. I argued that the discourse materialised in the machine has a history in the field of engineering. Some of what it means to do 'good' research and 'to do good in the world' can be traced back to the post war hope for engineering a better world.

Chapter 5 examined Collections 2, 3 to describe how knowledge practices in different networks translated what it means to *learn*. As digital technology and services were increasingly industrialised and developed into consumer products, the discourse shifted to forging new relations between technology and learning and this in turn constructed *'learning'* and the *'learner'* in new ways. I argued that what counts as good research was increasingly tied to notions of utility, relevance, and quantifying outcomes. In writing this discourse history of *'where TEL research comes from'* I noted that the processes of change are messy, and what actually happens on the ground is beset by contingencies that don't always add up or make sense.

Collection 1: (starts in 1945)
  Fiction, science, invention and commerce

Collection 2: (starts in 1970s)
  Media, business, academy and quangos

Collection 3: (starts in 1997)
  Crisis years, policy, and practice

Collection 4: (1999 - 2009)
UK TLRP Programme and TEL
Programme calls for funding

Collection 5: (2007 – 2012)
UK TEL Programme and Projects
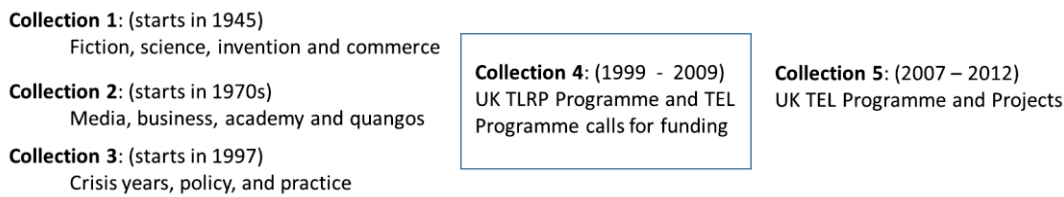
A schematic view of the Collection 4 as a vantage point and Collection 5 which includes material from the UK TEL Programme and Projects (2007-2012). Collections 2, 3, 4 and 5 are chronological.

Figure 6.1 A schematic view of the Collection 4 as a vantage point and Collection 5.

In these partially connected and disconnected accounts of TEL research, *'technology'* *'learning'* and what counts as *'good research'* are enacted in different ways. Yet these ontological differences often disappear in the search for intrinsic coherence.

Methodologically, this thesis is motivated by the possibility of understanding TEL research in new ways through methods of non-deterministic inquiry (Foucault 1976; Latour 2004; Law 2005). Part of the analysis in this chapter is presented in composite accounts. Composite accounts are a part of a motivated methodology widely used by actor-network theorist to attend to socio-material work that connects things and makes realities that are taken for granted (Mol 2002; Moser & Law 1999; Law 2004). These accounts involve rewriting the data to demonstrate specific points of analysis. In this sense, composite accounts are research constructs that perform data and analytical closures within the text of particular accounts, and in doing so they change or at least offer alternative ways of understanding familiar topics of TEL research. Technically speaking, composite accounts are devices to make more visible the performativity of coherent and non-coherent practices of TEL research.

The empirical focus in this chapter is on materials from Collections 4 and 5. These collections are described next.

Collections 4 and 5: Inventing the future of TEL

The schematic representation of the collections in Figure 6.1 is a reminder of the relative historical position of the collections. This chapter starts with collection 4 (vantage point) and in this chapter this includes the transition period from the UK Teaching and Learning Research Programme (TLRP, 1999–2009, £43m investment) to the Technology Enhanced Learning Programme (TEL, 2007–2012, £12m investment). Collection 5 starts in 2008 and includes materials from projects funded by the TEL Programme, materials from the TEL Programme publications and events, and from related international activities (Balacheff et al. 2006). The end point of the collection is materials from the TEL Programme final dissemination event on 6th November 2012. This event was the occasion for the premiere of the film commissioned by the TEL Programme, *Inventing the Future of Learning*, and the launch of two glossy publications called *Systems Upgrade. Realising the vision of UK education* (Noss et al. 2012), and *Beyond Prototypes: Enabling innovation in technology-enhanced learning* (Noss et al. 2013).

As in previous chapters, the aim was to include a wide range of data, and so the material covered here includes:

- publications in different formats, including videos, graphics, twitter, and brochures;
- materials that were produced for different audiences, including government ministers, teachers, young learners, industry, the public, and academics;
- international presentations about TEL research published on the internet; and
- material from practitioner bodies, e.g. Association of Learning Technologies.

Table 6.1 Examples of materials from collection 4 and 5 that are cited in chapter 6

This illustrates the chronological shifts in networks linked to TEL research and the change in format of the material published about TEL research.

Formats include: text in print and online as html and pdf, video footage in you tube, closed forums, multimedia demonstrations, social media, internet archives

	Chronology	Organisations (authorising networks)	Examples of materials from collection 4 and 5
1	Context of TLRP funding	UK Government office US National Research Council (NRC) UK Department of Education and Employment (DfEE). EU Commissioned and Funded TEL Programmes	DFES 2005; Whitty 2006; European Commission 2001
2	TLRP Programme 1999 - 2009	UK Economic and Social Research Council (ESRC) TLRP - UK's largest ever educational research programme. Learned Societies: e.g. British Education Research Association (BERA). Unions and Professional membership bodies e.g. Association of Teachers and Lecturers (ATL)	(Skinner 1958) (James & Brown 2005) *Report Principles into Practice* (Pollard and TLRP 2007) TLRP interviews summer (James and Pollard 2011)
3	TEL call for funding 2006 - 2008	E-learning centres of excellence (ran thematic workshops). Kaleidoscope Network (2004-8) STELLAR TEL network (2009-2012).	(Call for funding document 2006, 2007), *TLRP-TEL feedback workshops* (Noss 2007) (Carmichael & Patel 2007)
4	TLRP-TEL Programme 2007-2012	UK Economic and Social Research Council (ESRC) UK Engineering and Physical Science Research Council (EPSRC).Learned Societies: e.g. British Computer Society (BCS). Professional membership bodies e.g. Association of Learning Technologies (TEL) TLRP-TEL Programme Network £12m funding, 8 projects, 7 pilot projects. Four themes: flexibility, inclusion, personalisation, productivity.	(Cook & Noss 2010; Martinez-Garcia et al. 2012; Morris 2012; Tscholl & Carmichael 2011) *TEL project videos summe*r (2011). *TEL stories: Set of eight briefings on the TEL projects* (2010). *Event: TEL at the Royal Society* (2012). *System Upgrade: Realising the vision for UK Education* (2012). *Inventing the Future of Learning: TEL Programme Video* (2010). *Beyond prototypes: Enabling Innovation in Technology Enhanced Learning* (Noss et al. 2013)
6	TEL Programme 2012 and after		

This section is called Inventing the future of learning after the TEL Programme film of that name. This title capture something of the rhetoric of the UK TEL Programme projects that started with the TEL call for funding documents (2006, 2007), and EU networks like Kaleidoscope:

> Professor Michael Sharples, who directs the Learning Sciences Research Institute at the University of Nottingham……also Deputy Science Manager of Kaleidoscope, [says] Every era of technology has, to some extent, formed education in its own image. This is not to argue that technology determines education, but rather that there is a congruence between the main technological influences on a culture and the contemporary educational theories and practices…. With Kaleidoscope we want to offer a coherent European voice…."(Kleessen et a. 2006, p1)

Statements like this place value on coherence in making sense of the relations between technology and learning. But how is this coherence enacted and what happens to things that don't fit? These questions are taken up in examining the constructions of '*enhancement'* in TEL research.

The materials that have been selected for analysis and cited as data in this chapter are summarised in Table 6.1. The purpose of Table 6.1 is to give the reader a sense of the networks associated with TEL research, how these have shifted, connected and partly connected over time, and the kinds of materials that were analysed to trace the coherence and non-coherence in this fluid and entangled landscape of many discourses.

A vantage point: 'enhancement' in TEL research

As with earlier chapters, the first stage of analysis is to examine the UK TEL call for funding documents (2006, 2007), and in this chapter I pay attention to the construction of *enhancement* at the vantage point. Chronologically, the materials in Collection 5 come after the Call documents, so the vantage point is the beginning of what becomes of TEL research after 2007..

From the vantage point I describe the ways in which *enhancement* is non-coherent and how this is performed into coherence. The aim is write a discourse history of TEL research that recognises the will to coherence and the performativity of non-coherence. To be clear, this is not a different perspective on *TEL research*; clearly discourse regularities in the construction of 'technology' and 'learning' are performative in constructions of 'enhancement'. Rather, by drawing on Law methods text (2004), this inquiry is about drawing closer to the ambivalence of TEL research, and thereby describing in a different way the regularities that are performative in accommodating coherence and non-coherence.

To start with I describe three different enactments of *enhancement* that are contradictory, messy and partial, in other words non-coherent. These are referred to as: proper project management, proper methods and proper goals. Then*,* I describe three regularities that perform coherence so that the differences are managed, and *enhancement*, as a legitimate requirement of TEL, is rendered coherent after all. The three regularities are: translation, rational narrative and separation. These regularities are not mutually exclusive or exhaustive; they are examples of how action has been made possible.

So in what ways are constructions of *enhancement* research messy? To start with it is clear that *enhancement* is not one thing. This is clear from the range of statements that are like a shopping list of ambiguous signals:

> "When considering applications particular attention will be paid to the following research criteria:
> Consideration and fit to TLRP TEL Call
> User engagement and partnership…
> Interdisciplinarity….
> Contribution to knowledge…..
> Research Teams and Project Management……
> Research Design and Methods ……
> Contribution and fit to TLRP…….
> Contribution to Research Capacity Building……..

Communications, Knowledge Transfer and Impact Plan…….

Value for Money…..". (ibid 2007, p.15)

From capacity building to interdisciplinary teams, from value for money to rigorous design, some of the requirements are analogous to nonfunctional system requirements in engineering. Others are more like a procurement contracts. Enhancement as *proper project* management itemises project accountability, including timely delivery of outcomes. Naming these as research criteria characterises TEL research as a systems project, controllable by project management practices. But where are technology, learning and research in these requirements?

Things don't quite fit into the discourse of business and commerce when statements about enhancement stipulate *proper methods* of doing research. For example, researchers bidding for funding are asked to show that their proposal for a research design will support conclusions that a particular technological intervention was effective on its own and not the consequence of some other factors:

"• What is the nature of the evidence which will be collected in respect of these outcomes?

• How will such evidence be analysed in respect of learning outcomes?

• What provisions are to be made in the research design to support conclusions about the effectiveness of the intervention, rather than the influence of any other factor? (ibid, p.9)

This statement associates TEL research with a powerful network, which, since the 1990s has been encoding in US legislation (*Education Reform Act* 2002) with the prescription that education research be scientifically based. In this discourse the critical signifier of science is randomised trials (Harris & Marx 2006). In other countries, including the UK, parallel initiatives aim to promote a limited repertoire of predefined research methods. Findings from research that uses 'proper methods' is regarded as evidence, and such research qualifies for inclusion in meta-reviews of research (Hattie 2008). An important accolade is that this type of research contributes to cumulation of knowledge about education and learning. Examples of such

practices include the *What Works Clearing House* in the US[30], and the *Evidence for Policy and Practice Co-ordination Centre*[31] in the UK.

This is messy. Prescriptions about 'scientifically based research' conflict with requirement to collaborate across disciplines with peers, practitioners, policy makers and learners. The longstanding practice of peer review, where experts in the field make judgments about the quality of method, is different from moves to prescribe universal technical qualities that must be met in order for research to be considered legitimate, fundable, unbiased and objective (Yates, 2005). Moreover, there is consensus amongst some researchers that ethical issues in education research make controlled experiments untenable (Brooks et al 2014; Peters 2004).

Proper methods are associated with *proper goals*, in statements like for example:

"The calls encouragement of a focus on 'learning outcomes' requires serious consideration and will need explicit attention in any research design." (ibid, p.11) 'Learning outcomes' is a policy and practice category that is conceptually contested in that researchers don't agree on what it is and how useful it is (Edwards et. al. 2004; Chappell et. al. 2003, 2005). This common knowledge is at odds with policy directives that simplify the relationship between methods and goals. Researchers, who are bidding for funding are forced adopt the language of policy and write about the nature of the evidence that will be collected and how this will be analysed.

What is going on when policy discourse stipulates the conditions of funding research? One possibly binary interpretation is that this is a conflict between researchers and politicians. In other words a collision between "the culture of free inquiry that bristles at governmental encroachment and the equally compelling culture of democratic accountabilities that demand evidence that public monies are wisely spent" (Feuer et al. 2002, p. 6). This can be understood as collision and a

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[30] This is essentially a series linked websites including the American Education Research Association conference website and www.ed.gov.offices.IES and http://www.wwcinfo@w-w-c.org viewed 28 November 2015

[31] In the UK the department of Education and Skills (DfES in 1999 – 2010) and the National Foundation for Education Research (NFER) and the EPPI Centre (the Evidence for Policy and Practice Information and Co-ordination Centre of the Institute of Education University of London), were involved in producing a database of current education research in the UK (CERUK). See http://eppi.ioe.ac.uk and http://www.dfes.gov.uk/research viewed 28 November 2015

mess but something else is going on because TEL call documents (2006, 2007) give researchers enough to work with to bid for funding. There is non-coherence (mess) but in practice coherence is possible.

Having described mess, I now turn to regularities that perform coherence so that the differences evident in the statements about *enhancement* are rendered coherent. To say that the TEL call document was performed into coherence means that it worked and action was possible. To put it another way, the document was recognisable as a call for funding, bids were submitted, and projects were funded. Translation, rational narrative, and separation are three regularities that handle non-coherence and preserve a general commitment to ontological singularity, and they do this in different but overlapping ways. These are regularities that enact orderly conduct.

The first regularity is translation. Translation works by turning one thing into another so that differences are not visible. For example, in the Call documents (2006, 2007) questions about 'design of technology for learning' or 'design of pedagogy with technology' are (controversially) turned into questions about measurable learning outcomes. Research criteria are turned into a catch-all of project requirements, and measures of research quality are turned into value for money. Qualitative statements about quality of research are translated into work packages, percentages and currency that also stand for value for money. In the examples here, translation works by discipline the researcher to write particular kinds of coherence. It says to the subject (researcher) that a condition of being a funded researcher is to write bids that promise measurable research outcomes.

The second regularity is rational narrative. This works at the document level to smoothly join rhetoric from different networks associated with TEL. For example, the Call document organises references to technology innovation alongside references to theories of learning from cognitive science, work with education studies and themes like productivity, personalisation, inclusion, and flexibility. These themes were first recognisable in the discourse of engineering described in Chapter 4. The themes were translated into policy goals, as described in Chapter 5. In effect, quite disparate networks are enrolled into the narrative by having a place in the document and this is possible because the Call document structure is coherent. The

report format is a familiar artifice and the form and content of sections like 'Context', 'Aim and Scope of the Call', 'Research Challenges' and 'Application Procedures' are familiar to researchers, practitioners and policy makers. The rational narrative, invokes cumulation of knowledge by citing a disparate range of prior work, and rationalises TEL research as a coherent enterprise. Differences are subsumed in the narrative. It says anyone who comes this way, and only this way, is allowed to be a funded TEL researcher.

While translation handles non-coherence by reconstructing differences as unproblematic, another tactic is to perform coherence by separation. This is the third of the tactical regularities. There are statements about enhancement in the TEL call document that are mutually exclusive. For example, it is not possible to both conduct controlled experiments and simultaneously engage users in participatory design. It might be possible if these were separated, that is located in different physical spaces, conducted by different types of researchers, or scheduled at different times during the project life cycle. Another example is enhancement in relation to the software development strategy for sustainability beyond the life of the project. The TEL call document requires that software output is open source and at the same time commercialised for profit and copyright protected. In both these examples the contradictory visions of enhancement are separated in different parts of the text so that the researchers bidding for funds are invited to take up what fits their proposal. In this way textual and enacted separations sustain a general commitment to coherence without producing a singular account of enhancement.

In this section, I have described some tactical regularities but there is no suggestion that these three are mutually exclusive, and probably there are others. The analysis is by way of setting the stage for the rest of this chapter. In Chapters 4 and 5 I analysed the TEL call documents (2006, 2007) to examine the discourse regularities in constructions of technology and learning. These chapters were about where those regularities came from. In this chapter the idea of a unified and singular discourse history is disrupted and attention is turned to '*What is TEL research?*' This is in a world that is both coherent and non-coherent at the same time. This means that this

chapter is about performativity of enhancement in TEL research, where both coherence and non-coherence are inevitable.

Forms of ordering

In order to provide some (provisional) answers to the question *What is TEL research?* this section explores forms of ordering. Law (2014) writes:

> If reality is endlessly fuzzy, endlessly messy, or endlessly non-coherent, then the repertoires for holding things that don't quite fit together are similarly flexible and fuzzy. The one thing that is clear is that purity without impurity is a chimera, it is a performative chimera, yes, for the will to purity is powerful; but it is none the less a chimera. (p. 23)

But if everything is non-coherent it becomes interesting to know how this works in practice. Forms of ordering are accounts of practices that aim to describe non-coherence and coherence, and regularities that accommodate both so that action is possible. So far in this chapter I have described regularities at the vantage point, that is how *translations, rational narrative, and separation* work in the text of the TEL call document (2006, 2007) to make the action of bidding for funding possible.

Foucauldian discourse analysis and studies that draw on actor-network theory share a commitment to allowing and not reconciling non-coherence. Mol (2002) and Law (2004) use the term 'multiplicity' to describe coherence and non-coherence in practice. Fenwick and Edwards (2010) write " Multiplicity, or what Mol (2002) has called the problem of difference is the important awareness in after-ANT inspired analysis of different coexisting worlds." (pp.157-158). The task ahead is to allow and not reconcile differences, and to do this, discourse analysis is combined with composite accounts that describe non-coherence (Traweek 2004; Mol 2002). Guidance on how to do this was developed in Chapter 3 by drawing on Law's work on multiplicity. In the next sections discourse analysis is extended to include the following:

- examining statements about enhancement that is being claimed and how this is persuasive;
- inferring what assumptions about reality and discovery are common across statements;
- writing composite accounts that show how enhancement is non-coherent; in other words, how multiple conflicting enhancements are enacted simultaneously; and
- characterising how particular forms of ordering work to coordinate non-coherence so that action is possible.

In the previous section the analysis focused on Collection 4. The scope of the analysis is now widened to Collection 5. Four *forms of ordering* are explored and in each case data is presented as both statements and extended composite accounts that perform the mess and the argument (Suchman 2002; Law 2000, 2004; Haraway 1991). The four forms of ordering are: *knowing denial, persuasive packaging, domestication moves*, and *crafted conflict.*

Knowing denial

The will to purify is powerful when it neither recognises non-coherence nor tolerates exceptions. In this form of ordering, what counts as TEL research is the public record of who is funded as a TEL researcher to do TEL research. Critically, this identity of being a TEL researcher and TEL research project emerge from relations with software that is part of a governmental socio-technical system of tracking public funds. As a form of ordering, knowing denial can be characterised by: (1) a rationalised systems of audit (created coherence), and (2) non-coherence and tacit know-how about how funding works so that things that don't fit are enacted into coherence. Each of these is explored below.

The first characteristic is about creating coherence. Like other research funded by government bodies, TEL research is performed in and by what can be described as a *rational audit system* that does particular kinds of work to create coherence. Figure 6.2 illustrates two elements or statements (S) from the ESRC end of award report (Lally et al. 2013).

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S1   "The final instalment of the grant will not be paid until an End of Award Report is completed in full and accepted by ESRC. Grant holders whose End of Award Report is overdue or incomplete will not be eligible for further ESRC funding until the Report is accepted. We reserve the right to recover a sum of the expenditure incurred on the grant if the End of Award Report is overdue."

S2   **a) Objectives**

Please state the aims and objectives of your project as outlined in your proposal to us. *[Max 200 words]*

A. Development, user engagement and co-design
(i) To create Inter-Life: an integrated educational environment of Web-based and Mobile technologies. **DONE.**
(ii) To make the Inter-Life environments capable of co-design and re-design by users and developers through a series of generic scripting tools. **DONE.**
(iii) To develop a coherent set of Educational activities. **DONE.**
(iv) To connect participants to Inter-Life through their PC, Mobile phone, and mp3 connection. **DONE.**

(Lally et al. 2013, p.1)

Extracts from the End of award report form a project funded by the TEL Programme. S1 is generic text included in the form. S2 is input by the award holder.

Figure 6.2   Statements from an ESRC End of award report.

What follows is a composite[32] account of monitoring and reporting processes for TEL-funded projects in the UK, and the TLRP-TEL Programme (2009–2013). The account references the statements (S1 and S2) in Figure 6.2

Every project has a unique number. The number and the badging of ESRC and the programme has to appear on all outputs (software, journal papers, conference slides, publicity material and PhD thesis). The funding was released only when an accredited institution of Higher Education in the UK and a named grant holder sign contracts that are legally binding. Regular reporting is stipulated at set intervals and tied to release of funds (S1). The reporting forms

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[32] Sources: Lally 2013; Noss 2010; Carmichael & Patel 2007; ESRC guidance for grant holders web site http://www.esrc.ac.uk/funding/guidance-for-grant-holders/ viewed 12 November 2010

mirror the ones used for the bidding process so the exercise is about delivering to contract (S2). The final reports are peer reviewed.

The Programme also has reporting schedules and part of this is to collect numerical data from the projects and its own activities to comply with ESRC general indicators for reporting to government. One strand of the ESRC reporting process involves filling in a form, which begins by asking for the name of the investment. Investment refers to the main unit of funding, which in this case is TLRP-TEL Programme. Each investment is scored against key performance indicators and evidence of performance. An example of this "Indicator A: Activities and events involving the general public" (Noss 2010, p.2). Reporting requires the number of participants and a percentage estimate of the members of the public engaged.

In this form of ordering, what is TEL research and, by association, enhancement? In the ESRC form (Figure 6.2: S1), enhancement does not feature at all. This part of the system is the software package used to manage the Programme funding. Instead of talk of enhancement through research, there is reference to the legal condition of funding as a service contract, with the final deliverable being an 'End of Project Report'. The format and content of reporting is constrained by the structure of the electronic form (a table, maximum number of words, number of entry fields, and email for submission and so forth), and the software is designed to monitor compliance against a schedules of deliverables. In this way reporting of enhancement is built into the system and successfully meeting research objectives is entered on the form. The software will alert the funding manager if the report is missing, and will be returned by an administrator if any parts of the form are missing. As the final report is an audit of what was promised in the bid document, the required response is mostly a binary 'DONE' or pending. This is what the administrator will look for before the report is sent out for peer review. Accounts of enhancement do feature as research objectives, but the system is only interested in a simple account of 'DONE' or the reason why a promised objective (i.e. enhancement) is pending (Figure 6.2, S2). The pedagogical account of, for example, "Coherent Educational activities" as

'DONE' could be a book, a course, or a couple of questions on a blackboard; the system is not interested.

The compliance network is a powerful system in that final reports published in the national ESRC/EPSRC archives stand for reality. In other words, once in the public domain, records stand for what actually happened, what was done and achieved. It seems that quite quickly the archive becomes a public resource so that researchers, and other interested parties follow the system by treating the representations entered into the forms as standing for, a more or less accurate representation of truth. TEL research inscribed in ESRC and EPSRC archives comes to stand for *What TEL research is*. This documented by Foucauldian scholars as the archive that comes to represent reality (Steedman 2002). In this sense, the combination of software functionality, design of the forms, and the authority of national funding bodies is an assemblage that constructs facts, and realities that stand for truth.

But what about non-coherence and things that don't fit? I now want to show that researchers both defer to the authority of national records and know that this is not the whole picture of how things work. The system is performative in stabilising public accounts of TEL research, and funded research in general, but this is only possible because tacit know-how accommodates non-coherence. A lot of work (skills, experience, know-how and judgement) goes into refining entries on these forms. How to do this work is a legitimate (recognised) topic in the training and development of new researchers.

Here is a composite[33] account of the backstory about funded TEL research.

New researchers learn from experts how the system works. At one of the TLRP/TEL Programme events, new researchers and experienced principal investigators were discussing managing the process of bidding for funds and then the reporting process when a research is funded. "It's all about carefully choosing the right words and picking the right numbers. Take care not to say you are going to do anything that is not half done already. The trick is to

[33] Sources: TEL Programme Events on 'Research Capacity Building and Early Career Researchers', 'Challenges of building TEL as a Discipline', and 'Ethics in TEL workshop' 2009–2010

include objectives that are already work in progress, so that a good percentage is more or less 'DONEs' before the project is funded. This is work that you are going to build on anyway. Respond to peer review by showing critical awareness of difficulties, but not so much that the issues can't be tackled. Show how issues and risks will be mitigated. Leave the door open for future research; don't say it has all been done and dusted. Funding councils like numbers because these are easier to take in at a glance and make comparisons simpler. Look at other bids to understand how numbers are used. Well, you can only do your best with that. Use your judgement and ask colleagues to comment. Bids are peer reviewed; it's a small community, and convincing your peers is good enough to get funding.

This composite account draws on observations on a workshop that was well attended by early career TEL researchers. An experienced TEL researcher (expert) is presenting common knowledge. Insiders know that securing funding for research is the way to get academic careers started, and the means by which new researchers build their reputations for doing research and for administrating public funds. The reference to peer reviewing a not necessarily a sign of patronage because how peer review works is common knowledge. The implication is that experienced researchers, including peer reviewers, exercise judgement and do not take the numbers literally, even though the numbers are scrutinised carefully. Judgement is exercised so that knowing denial of mess is also performative. In the UK, those who are recognised as successful researchers are ones who have won funding and completed projects. Somewhat recursively, the answer to the question, 'How is this known?' is that the information is published in the ESRC/EPSRC archives of funded projects (including funded and completed PhDs). Named presence in this system can launch careers, help future bids for funding, build reputations, and open up access to other connected networks and organisations.

Although the reporting process might ignore everything other than what is input into the system, it is a *knowing denial* because the people who design, manage, administer, and otherwise maintain the system know that research projects are invariably messy. The doing of research can be planned but contingencies are

inevitable. Movement of staff, institutional politics, difficult relationships, access, ethics, travel, competition, clash, anger, birth, marriage, death, illness and more – generate non-coherence. The reporting process neither sees nor cares about this hinterland, and academic success (i.e. promotions and further funding) depends on the combined performativity of coherence and non-coherence, in other words, *knowing and denial*. The system does not depend on any particular researcher, theory or line of inquiry; it can carry on regardless. From this analysis *enhancement,* it seems, is appropriated by the system.

Persuasive packaging

The packaging of coherence is persuasive when the accounts and images about TEL enhancements are designed to captivate, seduce and in other ways engage the audience. Critically, the discourse of democratic accountability (as conditions of funding) extends the audience of peers, (i.e. other academics and researchers) to include "policy makers, practitioners, potential adopting organisations" as well as "learners and the public" (TEL call for funding 2007, p. 13). The TEL programme employed public relations/marketing consultants[34] to run a multimedia public relations campaign to raise public awareness of TEL research and its achievements.

TEL programme communications with project researchers from 2011 show that all the projects funded by the programme were invited to engage with designing information for dissemination beyond the TEL research communities and, at the same time, outsourcing the packaging of TEL research to media professionals and invited non-researchers[35]. Outsiders (i.e. non-researchers) who presented TEL research included: camera crew, a film director, sound engineers, a script writer, information designers, media editors and marketing consultants. These people were briefed to design accessible and engaging narratives that packaged TEL research into a series of public broadcast multimedia streams, including videos, twitter, newsfeeds and print. This production process was carried out alongside the more recognisable

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[34] http://tel.ioe.ac.uk/programme-publications/ Examples of professionally produced PR and marketing material. viewed 24 Nov 2015

[35] http://tel.ioe.ac.uk/2010/09/tel-on-video/ TEL Programme Projects on video YouTube Channel viewed 17 November 2015

academic practices of publishing in journals and presenting at conferences. As a form of ordering, persuasive packaging can be characterised as: (1) packaged performances of coherence, and (2) the productivity of keeping different accounts apart. Each of these is described below. The section ends with an example of a discursive shift that is a contingent effect of persuasive packaging.

What does it mean to performing coherence and package it? I illustrate this with examples from a short film entitled *Reinventing the Future of Learning*[36] (2012). This was premiered at a public event marking the end to the TEL Programme and offered as a public account of TEL research and the enhancements that it achieved. The film prompts some questions: What is being packaged? and How does this work to perform coherence in this public account of TEL research?

Here is a composite account of the closing event of the TEL Programme. It describes the opening scenes from the film and the premiere at the Royal Society TEL Programme event on 6th November 2012.

There is quite a buzz in the room as people file in through various doors; the demonstration areas and displays disappear as the doors are closed. The room is full. In the row in front of me there is a class of school children in their uniforms, accompanied by their teacher. I see the familiar faces of colleagues from the TEL-funded projects and others from the media, mainly politicians and journalists. I learn later that 200 people attended the event and that the audience included educators, students, policymakers, IT industry representatives, academics and the general public. Part of the occasion is the premiere of the TEL-commissioned film *Inventing the Future of Learning*.

The film opens with a man about to answer a question. We are not told who he is. The background is a blue screen and he talks reflectively as if dredging out memories from long ago. He says: "I was always interested in a notion of machines with memory, I remember, around about my twelfth birthday I was given a tape recorder. I went around explaining to everybody that it was a

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36 https://www.youtube.com/watch?v=8FBC496ggF0 viewed 17 November 2015

machine that remembered things." A sliced-in image of a tape recorder reminds us that he is talking about a pre-digital technology. The woman sitting next to me in the audience leans over and whispers I had one of those.

The film moves to another recognisable public face remembering his early encounters with technology. This time the speaker is in front of a bookcase and talks quickly and enthusiastically: "I did really brilliantly at O Level English literature because I'd seen Great Expectations the film not because I had read the book…" The scene cuts to the atmospheric graveyard scene from Great Expectations, the 1946 film directed by David Lean. I look at the children in the row in front of me and the audience around; they are watching the screen, captivated by the drama. I remember that the graveyard scene in *Great Expectations* is a cinematic trope.

The film now shows a third speaker looking away from the camera into the middle distance. He says: "I did not discover computers until I was a teacher and then one of the parents gave the school a computer. I learnt a lot, and that experience just switched the light on for me and I thought this is a good way help people learn." The screen shows an image of a rudimentary Acorn 6502 Microcomputer Kit (circa 1979), clearly digital but without a screen.

The film gathers momentum by moving through an urban landscape of public places and streets, with devices everywhere. These familiar and yet carefully composed images set the stage, and a familiar voice (actress Barbara Flynn) tells us: "People use experience and interact with technology in many different ways, but today our ambitions for education would surely not be realised without technology designed to help people learn. The aim of this film is to share a vision of how we can exploit technology to invent the future of learning" (verbatim script:1.38).

Screens from the film *Inventing the future of learning*. The screen illustrate images from four of the projects. In each case the screen is a combination of text, people in action, and technology in action. This segments is a visual experience of TEL research projects.

Figure 6.3   Images from the narrative of *Inventing the future of learning*.

TEL research in these opening scenes is set up as an experiential aesthetic. The audience is invited to suspend analysis, empathise with characters (human and technology) and enjoy nostalgia and familiarity. As entertainment, this works because the number and nature of thoughts that are evoked are left wide open for the receiver to interpret. This is experiential in that there is no opportunity for scrutiny or critique; the watcher is swept into the narrative world where technological *enhancement* is experienced as the future of learning.

Law (2000) describes this as a "form of narrative that distributes and performs pleasure and beauty … The subject in awe. The subject made in sublimity" (p. 24). But this is just the first part of the film; the rest is a combination of information dissemination and documentary drama.

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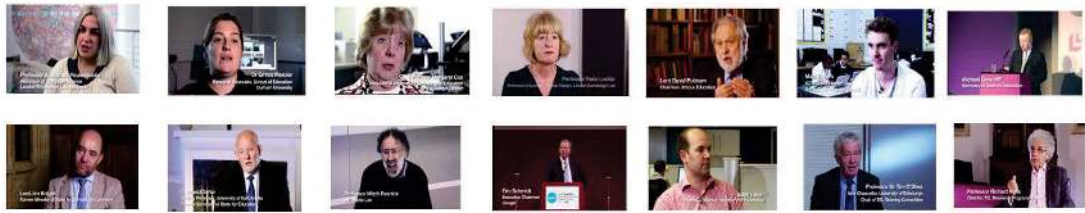
Professor Alexandra Poulovassilis, Professor of Computer Science, London Knowledge Lab, Birkbeck
Dr Emma Mercier, Research Associate, School of Education Durham University
Professor Margaret Cox, Professor of Education, Kings College, London
Professor Rose Luckin, Professor of Learner Centred Design, London Knowledge Lab
Lord David Puttnam, Chair Atticus Education
Matt Rogers, ICT Subject Leader, Snowfields Primary School
Michael Grove MP, Secretary of State for Education
Lord Jim Knight, Former Minster of State for Schools and Learners
Charles Clark, Visiting Professor University of East Anglia, Former Secretary of State for Education
Professor Mitch Resnick, MIT Media Lab
Eric Schmidt, Executive Chairman Google
Eben Upton, Executive Director Raspberry Pi Foundation
Professor Tim O'Shae, Vice Chancellor, University of Edinburgh, Chair of TEL Steering Committee
Professor Richard Noss, Director, TEL Research Programme

Assembling authority with images and sound bites from researchers, intellectual celebrities, politicians, and entrepreneurs and a teacher. This is in effect a visual inclusion of people from all the stakeholder groups identified in the original call for funding

Figure 6.4   Images and sound bites that authorise an 'invented' future for TEL.

Following the introductory sections, the film *Inventing the Future of Learning* is divided organised in two segments. Figure 6.3 illustrates some of the images that the viewer experiences in the first segment.

This segment is about the vision of the TEL Programme and the achievements of the eight projects funded by the programme. We are told that the potential for learning is evident across all eight TEL projects, all of which have developed systems and software that tackle some of the key pressing problems of teaching and learning and addressed a wide range of themes, such as personalised learning, productivity gains, increased flexibility, and more inclusive approaches to learning.

Over the next four minutes the screen is divided into segments showing images from each of the eight projects in sequence accompanied by a one-sentence description of the enhancement enabled by that project (Figure 6.3). These

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descriptions are intercut with excerpts from interviews with researchers. In one of the interviews there is an account of evidence from tests that showed learning improvements. We are informed that all the projects have included "input from both computer scientists and educationalists and, importantly, all of the projects that have worked with practitioners from the first day in an attempt to merge 21st Century technology with 21st Century pedagogy had to be embedded in practice" (verbatim script: 4.38).

Here is a composite account of the final segment of the film.

We are told that the thinking behind the TEL Programme is largely based on a constructionist approach, that is the idea that people learn best when they build things and share them with each other. The filming shifts to a documentary format and the narrative unfolds though the voices of international experts from academia and industry (Figure 6.4). There is talk of Seymour Papert's vision, 'good practice', 'scaling up the benefits', 'artificial intelligence', 'quality of design', 'teaching programming languages and constructs', 'raspberry pi' (hardware), and 'LOGO' and 'SCRATCH' software. One message is that TEL research is about making learners into producers of technology and not just consumers (teaching them what is under the bonnet). Another message is about rethinking what is possible to learn and think now that technology is everywhere. Yet another message is about how technology has the potential to more us forward as individual, groups and nations. There are sections that education researchers might find startling: comments from the CEO of Google Corporation on teaching computer science in schools; and the voice of government telling us that researchers need to take notice of decision-making timescales. In all of this, the viewer is left with a sense that TEL research is on the brink: "It is that dramatic we have created the equivalent of education machine guns" (Lord Puttnam, verbatim script: 15:56–16:17).

So what are TEL research and enhancement as packaged in the film, and how is this packaging persuasive? My suggestion is that the persuasive packaging is still

subliminal and works to produce the effect of truth in at least two ways. First, the film picks up the themes and priorities of the TEL Programme Call for Funding (2007) and reiterates the message that the funding has delivered what it promised. The images are from the project, but the actual description of each project could have come from the original TEL call documents (2006, 2007). Second, the truth effect comes from implying proper goals, methods and management. The description and images of each project refer to the documented trace of proper goals of each TEL project, and assert that these have been achieved and therefore the projects have been properly managed and proper research methods have been deployed. Central to the film is a carefully crafted reference to collaborations between computer scientists and educationalists, and engagement with practitioners. This is a direct response to accountabilities specified in the TEL call document (2006, 2007). In this way the performance of coherence relies on selective and condensed packaging of visual and verbal material to claim truths about the successes of the TEL programme, and the material for packaging successful outcomes comes directly from TEL Programme, official publications and reports to ESRC/EPSRC.

In addition to access to official material, the film makers had access to spokespersons from government and industry, as well as research. This is interesting because what gets drawn in is an eclectic mix of education theory (constructionism), hardware innovations (Raspberry PI, Tablet, phone), programming tools (LOGO and SCRATCH) and fields of research like Artificial Intelligence and Interface Design. Stepping back, these are categories that are being pushed together in seemingly unproblematic combinations, but actually they have a hinterland of quite complex controversy and ontological differences.

The film. *Inventing the Future of Learning,* is itself a material practice that blends non-coherence into a coherent narrative that makes space for enthusiasms and opinions, private projects and personal memories, along with the esoteric, contentious, obsolete and incomplete stuff of TEL research.

As a form of ordering, this is not unique. Law (2013) describes it as "collapse". He writes:

Things are being pushed together in an unproblematic combination. Those committed to the will to purity are going to feel queasy. The collapse looks confused. Indeed it looks like a form of *excess*. Though, and this is the crucial point, it isn't excess for those caught up in it. What looks like a hodgepodge to the purists instead makes practical sense. For as we have hinted the logic is ruthlessly pragmatic. (p. 11 italics in the original)
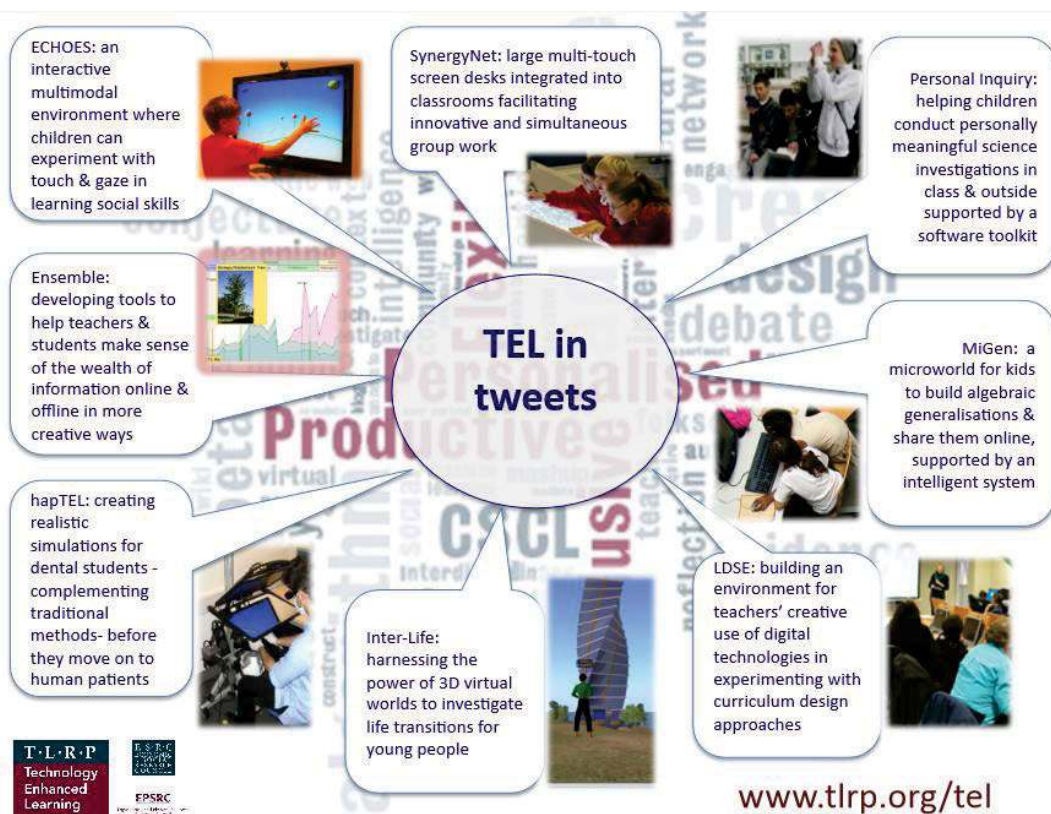
This image was produced in leaflets, and a poster works like a product advert. At a glance there is messages of 'progress through research', 'engagement of learners'. Different viewers can 'tap' into different messages 'being a scientist with technology', 'being creative with technology', 'social inclusion' and so forth. Project complexities are reduced to one sentence that come from the original bid for funding.

Figure 6.5   TEL research projects as tweet messages and flyers

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Not all persuasive packaging is the same. I have described the performance of coherence as narrative but in some cases pervasive packaging works by separating thing that don't cohere. I now describe the productivity of separating different accounts of TEL research. In this example there is an assemblage of images and text as illustrated in Figure 6.5.

Some public accounts of TEL research are only possible because of the affordances of communication and design technologies. This is explained by an example that demonstrates the assemblage of images and text (Figure 6.5). Following the rise of twitter[37] as a mass communication medium, the eight TEL projects were represented in 140 characters statements that were published in 2010. Tweeting the project signified the essence of TEL research on that project. Digital statements are easily edited, combined, redesigned and in other ways manipulated. Inevitably the TEL project tweets were repackaged. The redesign visually represented the tweets as utterances in a speech bubble (Figure 6.5). Each tweet was a statement about what TEL is for that particular project. Tweets were superimposed on one of the wordles[38] used extensively in the TEL programme marketing materials, and then positioned next to images from the project websites.

As official tweets, the statements were authorised by the project principle investigators and the programme director. The tweets and the subsequent flyer capture the beginning of minimal narratives that are translated into subsequent accounts of TEL. For instance, the beginning is followed up with stories about 'discovery and engaged users' (TEL Summer updates, 2010) and 'recommendations' (TEL Evidence Briefing Series ESRC, 2011), culminating in a final event 'TEL at the Royal Society' (2012). Audiences are familiar with this form of persuasive packaging; it features in the wider mass media, which reports facts in the news and follows up the news with commentary and discussion as review. If this is a form of persuasive packaging of TEL, what is it separated from?

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[37] A tweet is 140 character message supported by an online social networking service called twitter. Twitter was invented and launched in 2006 by Jack Dorsey, Evan Williams, Biz Stone, and Noah Glass. In 2014 Twitter had more than 500 million users.

[38] Wordle is described by its inventor Jonathan Feinberg as a toy for generating word clouds from text that is provided by the user. The user enters key words and prominence is given to the word that appears the most frequency.

The designs of the tweets and of the brochure from the tweets exemplify the design of plain facts. The tweets are constructions of plain facts as a kind of lowest common denominator, the minimum information that captures how TEL research is being tackled by each project. The plain facts are black boxes that are then the raw material that is reused or redesigned in future accounts of TEL research. Stepping back however, "There is no such thing as plain facts. All facts, plain or otherwise, are a form of persuasive packaging that selectively link things together, making facts by constituting some kind of truth-regime and effecting some consequences (Law 2000, p. 20). Persuasive packaging as a form of ordering is non-coherent because alongside plain facts that are not plain facts, there are other separate accounts of TEL research that are persuasive in other ways.

Here is a composite[39] vignette based on publication from one of the TEL projects called Ensemble (2008–2011):

The project explored the potential of Semantic Web technologies to support teaching and learning in a variety of higher education settings in which some form of case-based learning is the pedagogy of choice. The technology was taken up with some energy, even though in some settings, there remain significant challenges. The challenges are at the limits of problems that can be solved by TEL research. There are some problems that are moving targets, for example, the processes by which disciplinary and professional practice is mediated by teachers in classroom settings; how 'real world' cases are transformed into pedagogical ones; and the technologies that are needed to support and enable this kind of transformation. The view of cases, then, as mediating processes of assemblage, rather than as a containers or narratives, has taken Semantic Web technology development in unexpected directions. For example, *Dance Undergraduate Studies* was not an original setting for the project, but a combination of contingencies has made it one of the most

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[39] Based on publications by Martinez-Garcia *et al. (*2012), Tscholl & Carmichael (2011), and Morris (2012)

successful, a case study of how using Semantic Web technology to enhance the teaching of dance has been taken up as a use case by W3C[40].

The Ensemble project is still recognisable from the tweet about Ensemble: "Ensemble: developing tools to help teachers & students make sense of the wealth of information online & offline in more creative ways." (Figure 6.5)

Differences are also recognisable. The journal account problematises singular categories like 'case-based pedagogy' and 'semantic web', and it does this by drawing attention to contingencies of pedagogy, research and design practices. Journal articles are of course another performance of coherence and so a form of persuasive packaging. Academics are well versed in the form of ordering that is knowing denial. For particular journal readers it is possible to discuss a 'fuzzier' narrative, one that problematises disciplinary boundaries and is explicit about differences in enactment of case-based pedagogy and proactive opportunism in technical innovation. There is here partial overlapping between these different accounts of the project but mostly differences are handled by separation.

Sometimes the separation is temporal, when different kinds of writing are done at separate times. Sometimes the separation is around professional expertise. Researchers do research and are interviewed by film makers, or they hand over their text to marketing experts who redesign the message from the research and make it accessible for wider consumption. Divisions can also be controlling and hierarchical so that material produced for journals and the media are authorised by the principal investigators before they can enter the public domain.

This section on Persuasive packaging ends with an example of a discursive shift in which controversies are reframed as research problems to solve. This is illustrated in a comment by the former Secretary of State for Education, Charles Clarke. In *Inventing the Future of Learning*, he says: "I believe the key issue for the research community is to understand better what the decision-making timetable is for government" (verbatim script: Clarke: 15:32–15:35). This three-second comment in a 20-minute film buries controversy that pits 'research as independent inquiry'

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[40] The World Wide Web Consortium (W3C) is the main standards body for the World Wide Web.

against 'the government discourse of value for money and accountability'. At face value this is a common sense statement. What is not obvious is the power effect of this common sense in the text of the TEL call document (2006, 2007). Meeting governmental deadlines is a political problem, but here it is reframed as a research problem. It is the physical and material constraints of the time frame for delivering 'research outcomes' that determines what is investigated, how resources are allocated, how research is talked and written about, and, indeed, is the reason for investing in a marketing campaign that is primarily about public relations.

TEL researchers are expected to deliver outcomes to fit the government's decision-making timetable. Practices of persuasive packaging for the public (i.e. not a wholly academic or niche audience) has connected TEL research to other professional networks like marketing, cinematography and public relations management. With this shift, accounts of TEL research do not depend on any particular project, researcher or line of inquiry; they are more about communicating messages of enhancement and success and visions of the future. They do depend on fantasmatic discourse(s) that persuade, enrol, seduce and grip the subjects; and factualisation that changes complexity into simpler truths through information-design practices. These are emergent enactments of *what TEL is* and the persuasive packaging are public accounts of *where TEL research comes from.*

Domestication moves

The will to coherence is pragmatic when non-coherence is recognised and domesticated into something that coheres after all. Domestication moves is the third form of ordering. It is about the ways in which TEL research is rendered commensurable with providing evidence for practice, the scientific method and making recommendations to decision makers and practitioners. Law et al. (2013) describe domestication moves as a "thoroughly material set of homogenising practices … [that] come in many shapes and forms" (p. 6). But where are these domesticating accounts of TEL research?

At the end of the TEL Programme, the front page of the Programme website showcased three publications: the professionally produced short film *Inventing the Future of Learning* (2012), and two reports.

- The first report, called *Beyond Prototypes: Enabling Innovation in Technology Enhanced Learning* (Noss et al. 2013) , makes recommendations in answer to the question "What should researchers, funders and policy makers do to improve the translation from innovative prototypes to effective and sustainable products and practices?"

- The second report, called *Systems Upgrade: Realising the Vision of UK Education,* (Noss et al. 2012) makes recommendations on achieving "the massive ambitions we share, as a nation for education".

These are examples of the public-facing account of the TEL but what enhancement is being claimed and how does this work? These questions are now explored by describing: (1) contemporary relations between social reform and TLRP/TEL research; and (2) the construction of recommendations for practice and decision making. This section ends by considering effects of domestication as a mode of ordering.

So what are the relations between TLRP/TEL research and social reform and where does this come from? After 1997 there was a marked shift in the political discourse of education policy and because of the relationship between TLRP and TEL Programmes, this lineage extended to the funding conditions of the TEL Research Programme.

What follows is a composite[41] history of education discourse and the TLRP/TEL Programmes, 1997–2013.

In 1997 the Labour government under the leadership of Tony Blair came to power with education at the top of the agenda. "Education, education, education" as a rallying call was destined for the *Oxford Dictionary of Quotations*. Blair's thinking was influenced by the group of Oxford-educated

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[41] Sources: Seldon & Kavanagh (2005), Seldon (2007), Pollard (2005), and Noss (2007)

men that he had gathered around him to discuss the dependencies between policy directives around social justice and developing human capital as a national resource. The following three logics were at work in the ensuing discourse of education reform and research.

The first logic interprets research as a form of service to society. This is exemplified in the claim that the effectiveness of educational provision needs to be evaluated by reference to the goals and values of the society it serves. The education strategy that was rolled out picked up on three major strands of philosophical and political thinking on the purpose education (and education research). Broadly these strands were referred to in terms of economic productivity, social cohesion as inclusion (or control) of different groups, and personal development as a catch-all for valuing diversity and differences. The stress on inclusion represents the mainstay of the Blair government's approach to rebalancing the educational agenda in favour of social justice.

The second logic is about demonstrable progress. In simple terms this means showing that good things were happening. In education research this was translated into objectification of learning as a service product that is quantifiable as learning outcomes. Medicine is held up as the ideal and this in captured in the claim by the Director of the Australian Council for Education Research: "The purpose of medical research is to create and disseminate knowledge and tools which can be used to improve human health … the purpose of education research is to create and disseminate knowledge and tools which can be used to improve learning" (Masters, 1999, quoted in Yates, 2005, p. 17). The Blair government sought to manage the education system by setting targets, assessing performance and offering money on 'a something for something basis'.

The third logic is a policy version of positivist science ontology, where research has to demonstrate that it is scientifically based. For example, the influential 'No child Left Behind USA Act' (2001) refers to 'scientifically

based' research 110 times. In the UK, a collaboration between the National Foundations for Education Research (NFER[42]), and the Evidence for Policy and Practice Information and Co-ordinating Centre of the Institute of Education, University of London (EPPI) produces a database of current education research in the UK (CERUK[43]). The EPPI[44] emphasises its 'scientific base' for a literature review claiming that explicit and systematic methods are the primary bases for a reliable accumulation of knowledge. A political decision that only certain forms of inquiry will be funded is allied with the ontological position that only proper methods can discover truths in any field, including education and TEL.

Blair's government was committed to education and desperately wanted to be seen to be doing good things. A day without a new education headline was regarded as a day wasted. When Stephen Byers was Minister of State for Education, the number of press notices issued by the DfES went up by more than 50 per cent during New Labour's first year in office. Funding for the TLRP programme in 1999 and the appointment of Diana Laurillard to the new position of Head of the e-Learning Strategy Unit at the Department of Education and Skills was part of this wave of alliances between TEL researchers, education researchers and managers, politicians and policy makers.

The management team of the TLRP Programme described TEL as an add-on, an adjunct phrase, "TLRP's generic phase ran from 2000 to 2009. Some additional work on technology-enhanced learning (the TEL phase) completes in 2012." (James & Pollard 2011, footnote p.1) . Chronologically, the TLRP Programme preceded the TEL Programme by 10 years. TEL Programme managers and researchers inherited the relationships with politicians, funders and educators, including commitments that were transferred from education studies. One example of this is the attention to proper methods evident in the TEL call document, and "the application of findings to

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[42] https://www.nfer.ac.uk/   viewed 28 November 2015
[43] http://www.ceruk.ac.uk/ viewed 28 November 2015
[44] http://eppi.ioe.ac.uk/cms/   viewed 28 November 2015

policy and practice …[to] maximise the impact of the research and to present it in an accessible way" (TLRP aim 1999–2009). The point is that education research and TEL research were relationally entangled within a funding stream for educational research.

There is scant reference in the TLRP publications to any of the technology literature on TEL that was explored in Chapter 4. It was evident in Chapter 5 that networks of education research, and networks of TEL research, are not the same, although commercial opportunism forged some partial connections. TEL research came from engineering and cognitive science, not education studies. Effectively, there is something of a disjuncture between the discourse history of TEL research with its emphasis on inquiry by demonstration, experimentation, and trial and error; and the association between the TLRP programme and UK education policy, with its emphasis on quantifying outcomes and showing results within five years (the electoral life of a UK government). This is non-coherence that comes from exigencies of partial connections.

I now want to show how domestication performs the non-coherence of partial connections into coherent recommendations for practice and decision making. The analysis is organised by focusing on two very different documents published at the end of the TEL programme. These publications (P) are:

- P1: *Technology in Learning* (Cook & Noss 2010). This is a response to government. It is an exchange between government minsters, and spokes persons for TEL research.
- P2: *Systems Upgrade Realising the Vision of UK Education* (Noss et al. 2012). In the introduction Richard Noss writes "This report addresses 12 Key themes, with recommendations relevant to everybody involved in learning – including teachers, policymakers, lecturers and workplace trainers" (insert cover).

In 2010, John Cook the Chairperson of the ALT research Committee (UK), and Richard Noss the Director of the TEL research programme were jointly summoned to respond to a set questions from the UK Department of Business Innovation and Skills. Questions like:

"What works, in what context(s), to what extent and –if there is evidence – why and/or how? ….What are the improved learning outcomes (including quality and retention)?...Is there evidence of greater cost-effectiveness for the providers?....Of equal benefit would be to provide evidence of what doesn't work in what circumstances and why? It would also help if you could identify any major gaps in our knowledge where there is no properly grounded empirical evidence, since this might help direct future research (Cook & Noss 2010, p2).

 The questions were short and direct, suggesting an impatience that demanded direct answers. This came from a new coalition government and there is a sense of 'out with the old'. Terms like evidence, learning outcomes, cost effectiveness, gaps in knowledge and proper grounding are used by the questioners as uncontested literal terms that assume the meanings of these phrases are common sense. Questions like these translate complex research categories, such as 'students', 'teachers', 'learning' and 'institutions', into discreet common-knowledge terms that are familiar from public debates on television and in newspapers.

Earlier, as part of the composite history of education research, I described the logics of 'service to society', 'demonstrating progress', and 'scientific method' as particular to education reform. This discourse is extended to TEL research, and this is achieved by domestication moves. I describe how this works with examples.

The first example is about constructing TEL research as a beacon of 'progress' in which research is a 'service to society'. In its opening paragraphs, P1 states that "a range of sources conclude that with few exceptions teachers have not made any serious changes in the way they teach as a result of the introduction of technology for learning" (Cook & Noss 2010, p. 3). There is a tension here between the service model of education research and the more radical critique of pedagogy that is implied by referencing Papert (2000), who wrote: "A key to understanding why School is what it is lies in recognising a systematic tendency to deform ideas in specific ways in order to make them fit into a pedagogical framework" (p. 720). TLRP publications implied an incremental change around particular values, and these were transferred to the TEL Programme as themes (i.e. productivity, personalisation, inclusion and flexibility).

The non-coherence comes from quite different and sometimes mutually exclusive interpretations of research goals. Cook and Noss (2010) write about the efficiency of paying attention to existing processes but carrying them out in a more cost-effective, time-effective, sustainable or scalable manner. Differences between incremental consensual change and radial revolutionary change are collapsed by assuming that there is radical change and that this is consensual. For example, referring to work by Collins and Halverson (2010), Cook and Noss (2010) write: "The timing of this report could not be better. Education world-wide is currently undergoing a massive transformation as a result of the digital revolution … transformation that is similar to the transition from apprenticeship to universal schooling that occurred in the 19th Century as a result of the industrial revolution" (p. 4). Some forms of domestication work by allowing non-coherence and then collapsing differences in truth statements that are difficult to refute.

Another example demonstrates the difficulty of responding to questions that embody beliefs that 'learning outcomes' can be objectively quantified, and that proper scientific method will lead to truths about the state of affairs in the real world. The non-coherence comes from researchers recognising that research practices can't conform to this ontological coherence but then responding to politicians as if research practices are coherent after all. This is illustrated in relation to claims about generic benefits and evidence. On the one hand, effort is put into advising caution about claiming generic benefits of technology interventions: "…a problem with many studies is that they are inevitably conducted in situations where novelty, researcher attention, teacher enthusiasm and special funding may all have a role to play in the enhanced performance." (ibid, p. 5) On the other hand, writers of the report state that: "There is a large body of knowledge which could constitute a UK evidence base" (ibid, p. 5) This form of domestication works by including and not attempting to reconcile or problematise differences. Adversarial commentary and contradictory statements are separated in different parts of the document. In the spirit of something for everybody, separate paragraphs and separate parts of the document (including references) are written to be recognisable by readers from different networks.

Domestication of non-coherence is also evident in the *Systems Upgrade Report* (P2) (Noss et. al. 2012) , which like P1 is produced for a wider audience and makes recommendations for practice. Law (2004), commenting on social science methods, writes, "If we are interested in multiplicity then we also need to *attend to the craftwork implicated in practice.*" (p. 59 italics in the original). It is clear that the craftwork implicated in P2 comes from outside TEL research, from marketing and information design practices.

Extract from the TEL Systems Upgrade (Noss et al. 2012) Report page 2 published in print, online pdf and as a 4 page taster pdf

Figure 6.6   The message is fitted to the material constraints of colour, layout and word count.

An important idea is that the interests of all the various groups of people associated with TEL research are homogenised so that TEL research can be a unified field of inquiry, and a singular set of recommendations can "map out the territory of what we – academics, industry, policymakers' and practitioners – should recognise as crucial for getting the best out of technology and finding effective and productive ways to

invest for the future" (Noss et al. 2012, p. 3). This form of domestication works by joining the medium and message as in figure 6.6).

The advice to practitioners is illustrated in figures 6.6) Interestingly, there is little specificity of what action is recommended. Like an aesthetic response to the design and styling of consumer products, the options are to buy, recommend to others and/or enjoy. A continuation of this is that the report *Systems Upgrade Realising the Vision of UK Education* (Noss et al. 2012) is a thoroughly material product. The recommendation statements are reduced to fit onto one side of an A4 page. The publication mobilises a number of design tactics that construct coherence:

- The references to scale of funding and the size and number of projects and thematic strands suggest a powerful and important network of TEL researchers that is funded by national funding bodies. People who have never heard of TEL are left with a grandiose image of new frontiers and conquest.

- Mapping a territory suggests a unified field of research that can be mapped. The 12 themes, in the right font and size fit into the space available on the page. Fewer themes the outcomes would seem scant, more would overload the page.

- The list of words that signal the recommendations are upbeat or neutral, and there is an avoidance of negatives such as 'do not', 'be aware of', and 'avoid'.

- Common sense prevails. For example, "Exploit the power of personal devices to enhance learning" can be interpreted as both a truth and an obvious truism.

- Enhancement is implied by images that depict situations in which learners and various technologies (large touch Tables, interactive virtual reality, and mobile devices) are in the same place.

These domestication moves work by translating knowledge into a format that seemingly enables decision making and action. However, a consequence of these treatments is that recommendations are invariably ambiguous and open ended, and effectively comparable to propaganda. In some cases 'recommendations' are a vehicle for propaganda to convince the public, policymakers, politicians and funders that the cause of TEL research is worthwhile, and important to deliver education reform.

Crafted conflict

There is conflict when non-coherence is intolerable but has to be accommodated anyway. In this form of ordering, what counts as TEL research is constructed as the problem, challenge or barrier to making progress. In this form of ordering, accounts of TEL research and enhancement are only possible in relation to 'the others' that are characterised as defective, lacking or wrong in some sense. The phrase 'crafted conflict' is used because practices of critique involve discursive work, and this also extends to managing conflict. The crafting of conflict is what happens when non-coherence is *not* domesticated: "In large measure it is also a clash between different authorities and different modes of authority … and is only possible when different logics are bought together: for instance in the form of a demonstration in front of parliament, or by commentary in the press" (Law et. al. 2013, p. 9). Clashes of authority and crafting conflict (as a form of ordering) are evident in publications from the TEL programme and projects, and this is described in: (1) examples of conflicts around *enhancement* and TEL research, and (2) how relations between conflicting discourse are crafted. This section ends by considering the ritualising effects of conflict I start with an account of how non-coherence is enacted as conflict. Not surprisingly, conflict centres on claims about the success and failures of TEL research. This conflict involves apportioning blame and taking credit with a view to winning allies, securing future research funding, and surviving as a field of research. The non-coherence is described in terms of gerrymandering boundaries between groups that are set up the 'other', and therefore the problem. In terms of advocacy this is evangelical in its pitching of particular solutions and vilifying anything that does not fit.

Part of the gerrymandering involves separating the history of TEL research from the history of education research and this shares some of the discourse history of domestication (Smithers 2005, 2007). TEL research inherited accountabilities from the TLRP Programme that can be traced to a governmental response to what was regarded as the failure of education research to deliver enhancements. The notion that education researchers are responsible to society, and even for a better society, is a necessary part of the perceived failure of education researchers to deliver progress.

Official publications from the TLRP Programme seem to accept these accusations by acknowledging that education research had lost its way and had become irrelevant, too theoretical, too academic, of poor quality and jargon ridden (Pollard 2005).

Materials published at the end of the TEL programme celebrated the achievements of the TEL research and notably these were contrasted with the failure of the education system and, by implication, education research. This distancing is made to work by recalling the early history of TEL research and its association with cognitive science and computer science (this was explored in Chapter 4). A recurring argument is that research into digital technology and 'computers in education' had always been relevant and contributed significantly to society. One section of the *Beyond Prototypes* report (Noss et al. 2013) is dedicated to: "the UK's role as a world leader in this area and identifying TEL's role in developments as diverse as World Wide Web and the iPad" (p. 17). In this framing, *enhancement* is *not* a problem for TEL research. Indeed the possibility of enhancement is presented as inevitable in that technology is changing what is possible to learn, and technology makes the un-learnable more learnable (Noss 2011). The gerrymandering that separates TEL research from education research makes it possible to identify the education system (not technology) as the problem.

This discursive shift is messy (non-coherent). On the one hand, the problem for delivering the potential of TEL is described as the super-stable education system that is resistant to change and rational management (e.g. schools are dysfunctional in buying equipment that is not used). On the other hand, TEL projects are celebrated as successful in having an impact on education practice and practitioners and in focusing on pedagogy and not just technology. In another line of argument in *Beyond Prototypes* Report by the same authors (Noss et al. 2013) there is no clear divide between technology and learning.

In the examples of non-coherence described so far, both the practice of constructing the other camp and advocating a position or argument imply differences with some opposing group. I now turn to how differences are crafted into coherence. Crafting, like discourse, are enactments that follows particular patterns that are both

productive and limiting, but it is more situated in practice. Two examples of forms of crafting are described.

The first form works by separating differences into specialisations that can thrive in separate worlds and partly ignore each other. TEL research separated into different communities (see chapter 2). For example TEL research in computer/cognitive science research centres; is different from research published by e-learning practitioners; and the publications distributed by computer-based training departments in commerce and industry. Each of these is subdivided into specialist research niches that have their own conferences and journals. The point is that each of these groups has the capacity to develop research careers and researchers with different subjectivities and practices. Specialisation is a problem for policy makers and funders not for researchers. It interpreted as a failure to involve "learners, teachers, policy makers and industry", with the result that "it is difficult to complete the innovation process because experience, expertise and visions of educational change are not widely shared" (Noss et al. 2013, p. 24).

The second form of crafting conflict works by setting up a polemic. Adversarial, criticism and rebuttal are conducted by setting up a negative, opposite or undesirable state of affairs. Often the controversy is about characterisation of knowledge in relation to enhancing learning. TEL researchers coming from particular fields, for example, cognitive science, artificial intelligence and systems design, will be familiar with the characterisation of knowledge and learning in the May 2011 Report, *UK's TLRP Technology Enhanced Learning – Artificial Intelligence in Education Theme*. This is published by ESRC as a TEL Programme output. But consider this statement from the report: " Modelling is a central concept in AIED and increasingly rich models are being developed…" (p. 10). The assumption is that categories like 'learners', 'teachers' and 'meta-cognitive aspects of learning' are stable and can be modelled. Models are powerful forms of making coherence that formalise semantic relations for computable encoding. Tutorial systems are inventive and ingenious but ultimately rely on stabilising the representation of knowledge, knowing and learning (Suchman 2002). Barriers to adoption and everyday use of Artificial Intelligence in Education (AIED) are presented as the failure of education processes to develop new

pedagogies (Woolf 2010) and the failure of the AIED research community to engage stakeholders.

These are of course recognisably complex and non-coherent areas of conflict and, as with discourse formations, the crafting process is not only productive in making coherence but also limiting in what is possible to think about.

This section ends by considering the effects of crafting conflict as a form of ordering. Non-coherence is both accommodated and a source of conflict between different networks of TEL researchers. In the first example, conflict is managed because the separate networks of TEL research are separate discourse communities. In the second example, conflict is around the relative contribution and relevance of the different groups and the rivalry for funding

However when the staging of conflict is necessary for survival of particular groups, there are some troubling effects. For example, the time-bound, grant-funded projects tend to focus on technology at the expense of learning because it is easier to demonstrate visible results (Pastor et al. 2001). There is also the commodification of technology artefacts as objects of desire, for example, technologies such as One Laptop Per Child (OLPC) - make for attractive political rhetoric (Leaning 2010).

Another argument is about the dangers of technology evangelism that advocates technical global solutions to what are presented as global education problems, examples being big data gathering in the form of learning analytics, and massive open online courses (MOOCs). The framing of the conflict can also be described as ahistorical and divorced from the human–technology discourse materialised in the design of digital artefacts (see Chapter 4).

This chapter ends with a summary of forms of ordering that is illustrated in Figure 6.7.
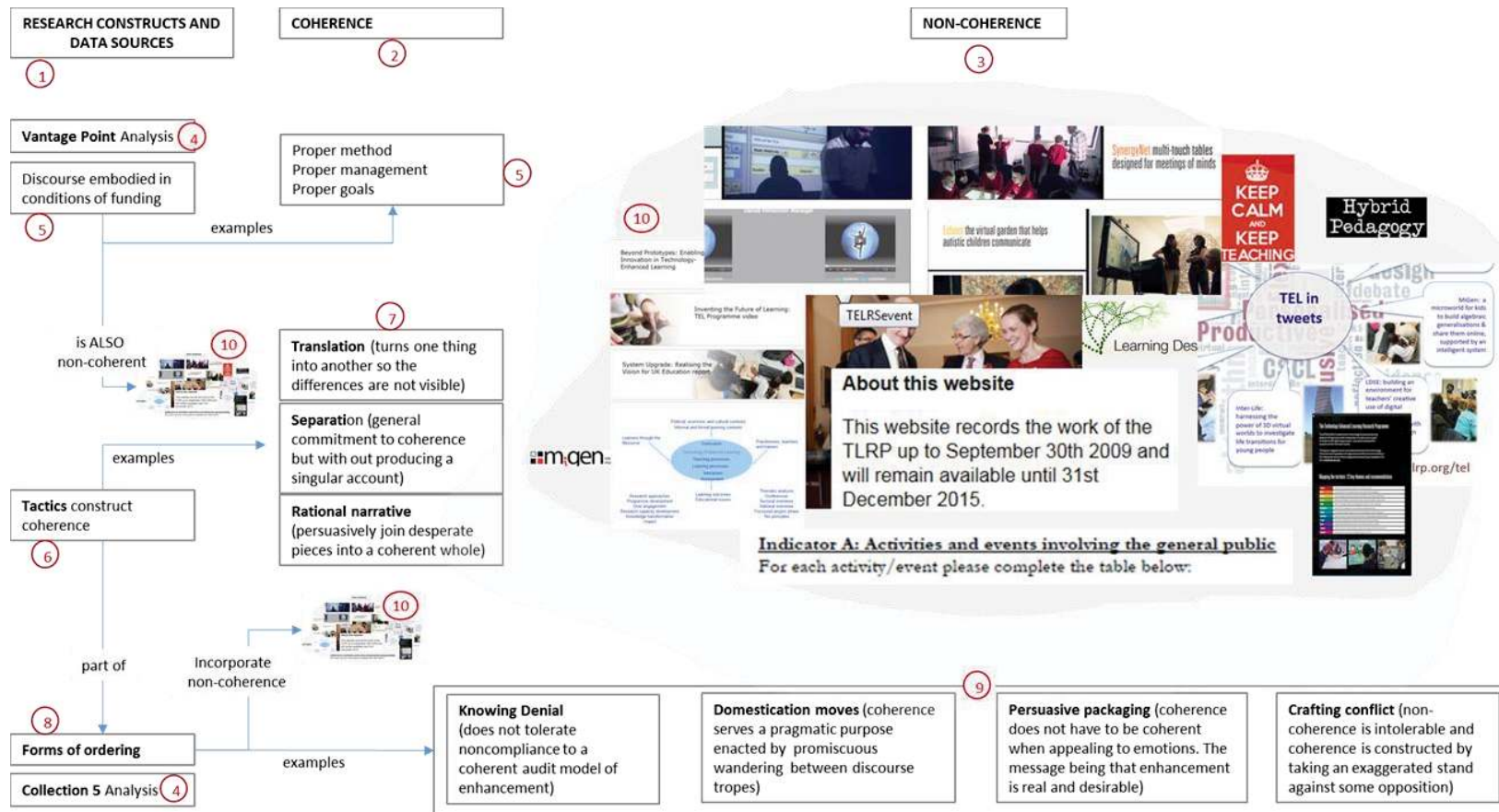
A schematic view of Chapter 6 illustrating the relationship between research constructs, data and writing accounts of coherence and non-coherence.

Figure 6.7   Relationship between data and how the analysis unfolds in Chapter 6.

Forms of ordering: a summary

Drawing on particular readings of actor-network theory, the introduction to this chapter asserted that coherence and non-coherence are both co-present and performative in any research practice (Law 2004, 2012; Mol 2002). In this framing, ontological multiplicity extends the grand sweep of Foucauldian discourse analysis to the messy enactments of discourse in practice. The rhetorical organisation of the analysis is experimental in combining composite accounts, with statements (S), images, and bricolage of data elements.

Paradoxically, I am writing accounts of coherence/non-coherence that are shaped into a coherence, and the focus on Collection 5 (where the analysis in this thesis ends) is rationalised but still an arbitrary cutting-off point. This point on reflexivity is not new since any research that is influenced by Foucault recognises that it is just as discursive as any other knowledge-production process. These arguments are taken up in Chapter 7, the final chapter.

Figure 6.7 illustrates schematically the research constructs that are described in this chapter, and how these are mobilised to describe the performativity of coherence and non-coherence (Figure 6.7: (1), (2), (3)). The map of the research in this chapter includes data sources because I argue that performativity is enacted in materials (Figure 6.7: (4)). Discourse(s) from science and engineering, systems management, and social justice was evident in the TEL call document, where enhancement was described in relation to proper method, proper management and proper goals (Figure 6.7: (5)). But the accounts in this chapter also illustrate that this enhancement is non-coherent and so messy (Figure 6.7: (10)). TEL research, and TEL researchers, are expected to deliver enhancements that are contradictory and conflicting. This mess is enacted into coherence, and to illustrate this, three example tactics that make this possible are described as: translation, separation, and rational narrative (Figure 6.7: (6), (7)).

The rest of the inquiry extended this attention to how coherence and non-coherence work to analyse Collection 5. I have argued that constructions of enhancement in

TEL research mobilise multiple ontologies. In this space, forms of ordering work like Foucauldian discourse formations in that they authorise and legitimate particular groups and forms of knowledge and power. Four forms of ordering are explored: knowing denial, domestication moves, persuasive packaging, and crafting conflict (Figure 6.7: (8), (9)). The accounts illustrate that discourse is not only powerful in the Foucauldian sense but also fragmented and non-coherent in practice as described by Law (2004).

This chapter has drawn together what may seem like random contingent events and entities: project reports, training researchers to play the funding game, videos, a film premiere, tweets and brochures, prestigious venues, demonstrations and presentations of demonstrations, photos of learners, audits of participants, numbers of conferences attended and responses to questions from ministers. However, I argue these are the empirical traces that make visible the specificity of work that is also the discourse history of TEL research. Forms of ordering reference the discourses materialised in TEL technologies (Chapter 4) and the translating relations (Chapter 5), and show how this works alongside non-coherence. In this sense, forms of ordering are like discourse but are also contingent, smaller, tactical, and specific to a time, place, text, film or event.

I have argued that discourse materialised in technology is difficult to reverse (Chapter 4); and translations of learning in TEL research have reduced the scope of TEL research to addressing instrumental questions (Chapter 5). In this chapter, the last of the empirical chapters, I have examined the discourse history of TEL research using different analytical resources from those of Chapters 4 and 5. This research process can be understood as an enactment of non-deterministic inquiry, that interferes with the absolute framing implied by my research questions *What is TEL research?* and *Where does it come from?*

Why does this matter? What can I claim about the work in this thesis? How have the three empirical chapters contributed to understanding TEL research? The final chapter in this thesis is about configuring endings.

Chapter Seven: Configuring endings

Journeys and goals have rather different properties. A goal is a fixed target, and influences the route taken to it. With an open journey of exploration, however it is not possible to predict what will happen: the purpose of the journey is discovery and the discoveries along the journey suggest new directions to take. One can suggest starting steps, and some intermediate way points, but not the detailed progress, and certainly not the end result.

A road ever on and on and on. J. R.R. Tolkien, The Lord of the Rings, 1954. Quoted in Journeys in non-classical computation : A grand challenge for computing research (Stepney et al. 2005, p.1)

Enactments and the realities that they produce do not automatically stay in place. Instead they are made, and remade. This means that they can, at least in principle, be remade in other ways. (Law 2004, p. 141)

Introduction

The general approach in this thesis has been more like charting a journey than aiming towards an end result. This is not so unusual. Witness the opening quote to this chapter from Stepney et al. (2005). However, journeying is unusual in the field of TEL research, in which recommendations from research, prescriptions for better outcomes, and guidelines for improving practice are the norm. But what has been achieved by deviating from the norm? The second opening quote, from Law (2004), is a reminder of enduring insight from non-deterministic inquiry that nothing is given in the order of things, although some realities are harder to undo than others. The empirical chapters (4, 5 and 6) consisted of many specific accounts of *What TEL research is and where it comes from,* and at times the significance of this discourse history may have been obscured by the details. In concluding this thesis it is appropriate to take stock and consider what contribution this thesis has made to new knowledge in the world.

To arrive at some conclusions this chapter is organised as follows:

- *Why this Journey.* This section is a summary of where the journey started, and the way markers along the way. In other words: where the research questions came from, why the thesis is about non-deterministic research, what makes this inquiry a discourse history of TEL research, and the bodies of knowledge associated with the inquiry.
- *Contributions.* This section is the substantive content of this final chapter, and is divided into three parts. The first part considers the methodological developments in the inquiry process in this thesis (Chapter 3). The second and third sections, draw on the empirical chapters 4, 5 and 6 to describe how this thesis has contributed to new ways of understanding and responding to the questions *What is TEL research?* and *Where it come from?*
- *Last words.* In this section I summarise the bodies of knowledge this thesis contributes to, and speculate on intentions and agency of the TEL researcher, and imagine the future of TEL research beyond the current boundaries.

Journey way markers

Chapter 1 of this thesis began by describing TEL research as a story of successful technological progress. In a space of 70 years (from 1945 to 2015), digital technologies have shifted from the stuff of science fiction to being woven into the very fabric of how we experience learning and everyday life. I argued that as well as a story of innovation and progress TEL research and the categories of 'technologies', 'learning' and 'enhancement' have an uncertain history of discursive interruptions (Chapter 1, 'Tell(ing) history')

A journey has to start somewhere. This thesis started at a particular period in the history of TEL research in the UK when the TEL call for funding documents (2006, 2007) were published. Funded jointly by the EPSRC and the ESRC the call was the next phase of the Teaching and Learning Research Programme (1999-2009). The Technology Enhanced Learning Research Programme (2007-2012) was aligned to

mainstream educational research, and the funding required TEL researchers located in the social, cognitive and technological sciences disciplines to demonstrate interdisciplinary collaboration. This was a formative time for TEL researchers like myself, who were exposed to colleagues and literature we had not previously encountered. This is how I came across the intellectual lineage of non-deterministic inquiry in the works of Foucault (1991, 2002), Latour (1979, 2005) and Law (2004, 2012). These writers are the source of the conceptual resources introduced in Chapter 1.

New conceptual resources allow the familiar to become unfamiliar. As a TEL researcher who has bid for funding to do TEL research, I was struck by the discursive work involving in putting a bid together and writing it, and the practices and subjectivities (including my own) that render this invisible. It was this strangeness that eventually prompted my research questions: *What is TEL research?* and *Where does it come from?* This was developed into a problematic of non-deterministic inquiry (see Chapter 1, 'The problematic'). As a shorthand title for the conceptual and empirical configuration of non-deterministic research, the work in this thesis has been referred to as the 'discourse history of TEL research'.

Initially the literature review in Chapter 2 identified some straightforward answers to the question *What is TEL research?* In some studies TEL research is characterised by technologies. In other studies it is content that defines TEL research. The literature review showed that TEL as a field of inquiry is recognisable in other ways: as self-differentiating communities; as an association of professional practitioners; and as part of policy narrative that aspires to bring about political change through funded research. Chapter 2 reviewed the kinds of knowledge that counted as TEL research, and found that the mainstream of TEL research is characterised as an applied field, that 'applies' knowledge from various foundational disciplines including computer science and cognitive science. The history of *where TEL research comes from* is deleted in this coming of age narrative. It is as if TEL research arrived from nowhere. There is a small TEL literature from the 1990s that proclaimed an intellectual commitment to deconstruction. This literature is concerned with critiquing *What TEL*

research is and is also disconnected from *Where TEL research comes from.* There is a growing TEL literature with a commitment to intellectual uncertainty of knowledge production but there are not archival studies on the discourse history of TEL.

Putting aside any *a priori* commitment to 'TEL as applied research' or 'deconstruction of TEL', there is a gap in knowledge and the problematic setup in Chapter 1 is new. In this thesis the questions *What is TEL research?* and *Where does it come from?* have been examined as a discourse history of construction. In other words how things come to be as they are, including amongst other 'things': technologies, networks of knowledge and subjectivities of researchers, teachers and learners. As noted in Chapter 2 there is no TEL literature that addresses the problematic as set out in Chapter 1. Therefore part of the journey has involved mobilising resources from bodies of knowledge associated with non-deterministic inquiry (chapter 3).

Through the research questions *What is TEL research?* and *Where does it come from?,* the journey set out to examine the constructions of knowledge boundaries. In Foucault's words:

> "By what criteria is one to isolate the unities with which one is dealing; what is science? What is an *oeuvre?* What is a theory? What is a concept? What is a text? How is one to diversify the levels at which one may place oneself, each of which possesses its own divisions and forms of analysis? (Foucault 2002, p.6)

This meant crossing boundaries, and making connections between academic fields, disciplines, and spheres of activity, like the media and politics. This ventures beyond what is usually regarded as TEL research. Never-the-less the way markers on the journey have been particular bodies of knowledge:

1. The literature on TEL as a field of inquiry (Beetham 2005; Conole & Oliver 2007; Czerniewicz 2010; Ely 2000; Hlynka 2004; Laurillard 2002).

2. The literature that consists of relational socio-material studies that focus on learning, education and technological innovation (Bayne 2015; Gorur 2012; Latour 1987, 1988; Laet & Mol 2000; Nespor 2012; Rimpiläinen 2012; Sorensen 2009).

3. The literature in Science and Technology Studies that examines the relationship between research, practice and policy (Adsel et al 2007; Latour 2014; Law et al. 2013; Strathern 2004).

4. The literature in education studies that is methodologically aligned to actor-network theory (Fenwick and Edwards 210; Fox 2005; Mulcahy 2007), and Foucauldian scholarship (Fejes and Nicoll 2008; Fox 2005).

5. The literature on archival studies (Brugger 2005; Geiger et al. 2010; Guthrie 2001; Steedman 2008).

From this list I refer to the first three in the rest of this chapter. These are the bodies of knowledge that this thesis has contributed to.

Contributions

The research in this thesis sets out to capture some of the discursive constructions of *what TEL is* and *where it comes from* and this means that if the world is assumed to be relational then so too is the text of this thesis. A recurring reminder in the works of Foucault, Latour and Law is that texts produced by researchers are as much relational constructions as any other knowledge in the world. This has influenced the sequence of writing this section on contributions. Though the contributions to methodology of this thesis are new to TEL research, they may be seen as being of less importance than the substantive contributions because they are not so new in fields like Science and Technology Studies. This would imply that accounts of methodological contributions should therefore come after the substantive contributions. However, writing first about the methodological contributions sets the stage for describing the substantive contributions of this thesis, and usefully counters

any inadvertent pretence that the empirical and conceptual are separable. I take up this latter rationale in organising this section.

The first set of contributions are about methodology. These contributions are about bringing non-deterministic inquiry into the domain of TEL research and draw mainly on Chapter 3. The second and third set of contributions, draw on Chapters 4, 5 and 6, and are written as responses to the research questions *What is TEL research?* and *Where does it come from?*

The inquiry

Yates (2004) writing about what counts as 'good' education research describes some recurring themes (see Chapter 3, 'Configuring the Inquiry'). In particular she draws attention to the inquiry process that can claim to be to be *novel, systematic, inventive and technically persuasive*. Working with these ideas, this section describes four contributions.

First, it is *novel* to frame the research questions: *What is TEL research?* and *Where does it come from?* as a 'discourse history of TEL research'. This was the conclusion from the review of the literature in Chapter 2. It is also novel that this has been pursued as an archival study. All the TEL research studies in the literature review date from 1990, when the commercialisation of digital services and products was well under way. The work in this thesis adds to this existing body of knowledge about TEL as a field of inquiry (c.f. Czerniewicz 2010; Squires et al. 2000). This has been achieved by opening up the possibility that TEL research has a longer relational socio-material discourse history.

Second, the thesis has *systematically* combined conceptual resources and empirical strategies to investigate the discourse history of TEL research. The ideas of 'a vantage point' enabled a consistent focus on *What is TEL research?* and acted on Law's (2004) normative guidance to interrogate the particular and the specific in making judgements about validity. The 'vantage point' located a specific historical

time, geographical space (UK), and materials embodied in the TEL call documents (2006, 2007). After it was introduced in Chapter 2, the 'vantage point' was mobilised to gather and organise data (Chapter 3). The methodology chapter illustrates how a relational socio-material inquiry can be systematically organised. This adds to a body of knowledge in education studies that is methodologically aligned to actor-network theory (Fenwick & Edwards 2010), and Foucauldian scholarship (Fejes & Nicoll 2008).

Third, the structure of this thesis can claim to be *inventive* in responding to what was found during the research process. Rather than asking what in a given period is regarded as TEL research, the empirical work traced the continuities, disjunctures and interruptions in constructions of 'technology', 'learning' and 'enhancement'. In this way it was possible for the intelligibility of the data to be both emergent and responsive. Each of the empirical Chapters (4, 5, and 6) describes *What is TEL research* at the 'vantage point', and this is followed by examining *Where [this] TEL research comes from.* Outside of this thesis, the collections are archived for other researchers to interrogate as new questions arise. An archival study is an addition to related empirical studies that rely on ethnography, case studies and documentary analysis (Fenwick & Edwards 2010; Fenwick et al. 2011; Knox 2014; Thompson 2015).

Fourth, an important maker of validity of an inquiry is the extent to which it is *technically persuasive*. For Latour's (2005) the normative challenge is to contribute better, more relevant studies of science and social science so that informed action is possible (Chapter 1). This can be understood as chasing what is technically persuasive rather than immediately simple and coherent. I did not start out with the intention of writing Chapters 4, 5 and 6 in different ways; this was a response to what emerged as convincing relations between the data and the conceptual resources. What emerged is that 'technology', 'learning' and 'enhancement' have separate discourse histories, even though these are un-problematically concatenated in naming TEL as field of inquiry (circa 2000 in EU and 2006 in the UK).

In each of the three empirical chapters, I emphasise a different construct from the conceptual resources, and a different data trail from each collection because it was more technically persuasive. In the process of doing this I have adapted writing and analysis practices from various disciplines and genres. Schematic diagrams, statements, archives, timelines, language constructs, rhetorical text, and images alongside analysis notes; these are not usually found together or in TEL research. In this thesis I mobilise these as the ordinary stuff of producing new knowledge. They are new ways of understanding and writing TEL research. The work in this thesis is an addition to other relational socio-material studies that focus on learning, education and technological innovation (Gorur 2012; Latour 1987, 1988; Laet & Mol 2000; Nespor 2012; Rimpiläinen 2012; Sorensen 2009).

What is TEL research?

Much of the empirical work in this thesis has been about how discourse works in a specific time and place, referred to as the 'vantage point'. The question *What is TEL research?* was examined in the call documents (2006, 2007) by analysing the construction of 'technology' (Chapter 4), 'learning' (Chapter 5), and 'enhancement' (Chapter 6). It was clear from this analysis that any notion of linear progression from pure to applied research, or the unity of TEL research as a field of inquiry, is misplaced. The accounts of *TEL research* in Chapters 4, 5 and 6 adds to the literature on TEL as a field of inquiry, and to *Science and Technology Studies* literature on the relationship between research and policy.

This section draws on the discussion in Chapter 1 on how Foucauldian scholars (Biesta 2008) frame the 'matter of new knowledge'. This is because responses to the question of *What is TEL research* can be understood as a practical critique that is "a challenge directed at what is" (Foucault 1991, p.84). From numerous possibilities, 4 response to the question *What is TEL research?* are described next.

A first response to the question *What is TEL research?* is that discursive work is involved in constructing TEL as an applied science. Ostensibly it would seem that

TEL research combines 'technology', 'learning' and 'enhancement' as equal entities, and much is made of the unity and coherence of this combination in the TEL call documents (2006, 2007). In these documents, statements about 'technology', 'learning' and 'enhancement' were examined separately. As described in Chapter 3 this sustained examination complicated and pluralized the elements and relations between statements at the vantage point. Chapter 4 described regularities that constructed 'technology' for example 'factualisation' 'segmentation' and the 'fantasmatic'. But then in Chapter 5, the data analysis showed that 'learning' as a category has associations with discourse from business, policy, and mass media. The regularities that governed 'learning' were described as a mesh of 'homogenisation', 'quantification' and 'opaque accountabilities'. In Chapter 6 the analysis showed the non-coherence of 'enhancement' and how this was constructed into coherence by invoking 'proper method', 'proper goals' and 'proper management'. Making this visible is a form of practical critique, because it challenges the blanket acceptance of applied science as a descriptor of *What TEL research is*.

A second response to the question *What is TEL research?* is that it is a coherent framing of research questions, that enacts non-coherence. Chapter 5 traced the history of association between TEL academics, and intuitions that are primarily concerned with policy, business and commerce. This analysis indicated that TEL researchers are willing subjects in articulating particular relationships between 'technology' and 'learning'. For example: Are semantic technologies good for case-based learning? Are pedagogical pattern tools good for teaching? Can intelligent micro worlds help 11 to 14-year-olds learn algebra? In general, what types of technology and forms of learning are a good match? These are more or less cause-and-effect type relations that imply the possibility of straightforward answers. Critically, the possibility of contingent discovery or emergent knowledge is rendered difficult to accommodate.

Chapter 6 described the rhetorical productivity of discourse in authoring these impossible TEL research questions. In practice, 'findings from research' cannot answer 'research questions' in the ways it is often claimed. This indicates that TEL

researchers know that what actually happens in practice is more messy than they can admit in public, not least because 'technology' and 'learning' are non-coherent categories. The work in this thesis is new in making visible these kinds of tensions. It is a practical critique of TEL research questions and their purposes, agency and enactments.

Third, there are other ways of understanding *What is TEL research?* The text of the TEL call documents (2006, 2007) was a gathering of forces that authorised the criteria for allocating research funding. Enactments of TEL research, as inscribed in the TEL call documents and related online apparatus, did what they had to do to achieve an orderly, transparent process of managing public funds. The funding was described as an 'investment' and in that language, 'return on investment' has a political history of controversy that pits academic independence against accountability for spending public money. Funding criteria in the TEL call documents changed these arguments from a matter of concern and discussion to the status of facts.

To become a funded TEL researcher, complying with the funding criteria is mandatory. But it was evident from the analysis in Chapter 6 ('Knowing denial') that this is not entirely hegemonic, and TEL researchers are not passive. Biesta (2008) points out that Foucauldian analysis: "does provide support for resisting or even refusing particular subjectivities or subject positions…and for *adoption* of particular subjectivities or subject positions." (p. 204 italics in the original). This thesis has sustained new enactments of TEL research, and that in itself is a practical critique of TEL research as an accountability problem.

The final response to the question *What is TEL research?* is that it has been enrolled into the discourse that legitimates policy knowledge. One way of reading this is that research into 'technology' and 'learning' are bracketed out in favour of 'enhancement', and 'enhancement' is translated into a political project to deliver social reform within the five-year UK election cycle. Chapter 6 ('Persuasive packaging') demonstrated that text, images and multimedia inscriptions can stand

with confidence and authority, thereby legitimising policy goals as universally desirable and achievable. Chapter 5 showed that this is possible because a chain of discursive shifts and translations has moved the associated politics from controversy to self-evident truth. TEL research as policy knowledge, is fabricated in the TEL call documents (2006, 2007), by references and other materials. Then again, as Gorur (2012) points out in her work on *The Program for International Student Assessment* (PISA) "that is what *makes it real,* what gives it relevance, what adds to its validity" (p. 73, original emphasis). Empirically tracing and documenting TEL research as a heterogeneous achievement highlights the role of humans and materials in truth making. This is a new way of understanding *What TEL research is,* and making this visible is a practical critique of received truths about TEL as a field of inquiry.

Where does TEL research come from?

Part of the motivation for examining the discursive construction of 'technology', 'learning' and 'enhancement' from the vantage point of the TEL call document (2006, 2007) was to find a way into exploring the discourse history of those three related categories. In other words: *Where does TEL research come from?*

The work in this thesis has shown that the origins of TEL research can be understood historically as two interruptions (in 1945 and around 1970) and conceptually as the co-existence of coherence and non-coherence. After 1945, TEL research was characterised by research into human cognition and digital technologies as information processing systems that could be engineered. After circa 1970, TEL research was characterised by the mass availability of digital artefacts such as computers, and digital services that include the internet and the world wide web. Conceptually, where TEL research comes from is characterised by the productivity of practices occurring when there are invariably multiple messy constructions of 'technology', 'learning' and 'enhancement'.

To recognise these empirical differences in the emergence of TEL research, this section is organised in three parts. The first part covers the history after 1945, the

second part from circa 1970, and the third is about the ongoing socio-material construction of TEL research.

The period after 1945

Looking at the period after 1945, I found that 'technology' and 'learning' as topics of research have a significant shared history of "collective experimentation" (Latour 1999, p. 20). Included in this history are the researchers, gurus and figureheads that speak for the group(s). Then there are publications, engineering facilities, funding, social spaces, conferences, R&D laboratories, projects and, in time, the personal computer, the internet and more. I examined the relevant research archives and found traces of discourse(s) that linked the design of technology with the design of learning. This work on materialising discourse (Chapter 4) is new in opening the black box of 'technology' and in examining the discourse of 'learning' that is materialised. To answer the question *Where does TEL research come from?* three response are discussed.

The first response *Where does TEL research come from?* is that it comes at least in part from the *discourse of engineering.* In opening the black box of technology what I found was the discourse of engineering dating back to post-war ambitions to build a better world through science. I characterised the parts of the discourse from engineering as: problem framing, deconstruction, demonstration and modularization / stabilisation. Problem framing works by turning discussions into problem statements in need of an engineering solution. It was evident from this early history that the same treatment was extended to the category of 'learning'. Solving the problem involves analytically deconstructing the problem into smaller parts and building a machine to demonstrate the solution. Demonstration of the augmentation system (Engelbart 1962), Sketchpad (Sutherland 1963), and MESH, the first web (Berners-Lee 1996), are examples in which 'knowledge' and 'learning' were engineered alongside the hardware and software.

These regularities from the discourse of engineering are taken-for-granted ways of designing systems, coding applications, and testing functionality. In these worlds they are recognised as design constructs, fabricated as real, but not real in fact. This is why in engineering disciplines the demonstration is important; it validates engineering fabrications. This is an interesting fragment of discourse history because it interferes with popular and academic accounts of where TEL comes from. Discourse from engineering is performative in legitimating and authorising TEL research as a form of a systems engineering, but there is a disjuncture between the actual practices of engineering and representations of some TEL research that claim objective truths.

The second response to the question *Where does TEL research come from?* is that it comes from *a variety of enactments.* A key point is that the discourse history of TEL research is not one of uniform linear progression. Instead, it is more like a variety of partially connected enactments. These are documented in Chapter 4, and here are a few reminders. There was a period in TEL history when design, learning and research were thriving practices amongst counter-culture collectives of fledgling hobbyists, hackers and technicians (Brand 1968; Isaacson 2013). At the same time funded researchers were located in cognitive science laboratories and in AI projects (McCarthy et al. 1955; Boden 2006). In the PLATO projects the learners and students where the researchers and inventors (Denenberg & Steward 1978; Woolley 1994). In another version of TEL research arguments about de-schooling were mobilised to justify the design of Logo as a programming language for children (Papert 1993). In yet another enactment of TEL research the Community Memory Project combined engineering with online community building (Slaton 2001; Szpakowski 2006). These accounts of *where TEL research comes from* is new knowledge in relation to TEL research. It recognises messy, faltering practices in which the fiction of digital technology came to be materialised into successful, and in some cases unsuccessful, technologies and associated learning practices. This is part of the discourse history of TEL research and it is new in demonstrating that people, technology and discourse are neither passive nor entirely in control of how relational connections are played out and come to either endure or dwindle.

The third response to the question *Where does TEL research come from?* is that it comes partly from *the agency of algorithms.* The agency of algorithms has escaped the boundaries of TEL research, and this exclusion is significant in reducing what is possible to investigate. Traces from the archives indicate that for most TEL researchers the scope of TEL research does not extend to the technical work of design or software engineering. Opening the black boxes is increasingly difficult. This does not mean the technical work, especially in relation to decomposition and processing techniques, has no effect on what TEL research is. There are other fields of research that look at where TEL comes from, notably science and technology studies, computer science, software engineering and commercial R&D. However, these are excluded by discipline boundaries (Sismondo 2010; Stepney et.al. 2008; Sommerville 2010). Chapter 4, on materialising discourse includes accounts of early web schematics and illustrates the potential for inscription systems to leave open the future possibilities of invention (Berners-Lee 1989). An example from the BBC Computer Literacy Project illustrates the opposite, when commercial and political alliances manoeuvred the design of computers from configurable tools into consumer goods (Allen & Albury 1980). Perhaps the most opaque turn has been the advent of dependable and responsive AI software based on 'trainable' probabilistic models (Russell & Norvig 1998; Norvig 2011). In these machines not even the designer knows how the algorithm does what it does. Yet these software modules are routinely installed in applications that process learning analytics (Sclater 2014). I have found that software and design practices produce particular kinds of knowledge and intelligence about learning, and that truths claimed are not independent of discourse materialised in the machine. This may not be comfortable intelligence but it is a start, and further research is needed to understand the implications of this for what and how we learn, and how we do TEL research.

Looking back to 1945 it seems that the discourse history of TEL research is also the history of engineering practices through which early TEL technologies were materialised. However, as will be discussed next, since circa 1970 this rich history of relations between humans and non-humans, of invention, exploration, hopes,

ambitions and endeavours has been gradually dropped from mainstream accounts of TEL research.

The period after circa 1970

My examination of research archives from outside the academy found that whereas 'technology' and 'learning' had been the *subjects* of research as phenomena to be engineered, a chain of translations has changed both into *objects* for other purposes, such as for example, entertainment, commerce, business, and policy goals. In the period after circa 1970, what was recognised as TEL research changed with the commercialisation of digital technologies. Broadly, commercialisation of digital technologies was piecemeal: reliable hardware components (1970s); affordable personal computer (1980s); increasing public access to the internet and the world wide web (1990s); and after 2000, the explosion of social media and access to information services (Campbell-Kelly et. al. 2013). In response to the question *Where does TEL research come from?* I will now summarise the discursive construction of TEL research in three networks.

Part of the discourse history of TEL research, that is *Where TEL research comes from* was traced to its association with broadcasting media. I have traced part of the discourse history of TEL research to the backstory of British Broadcasting Corporation (BBC). Some of the most intriguing findings came from archives associated with the BBC Computer Literacy Project (Radcliffe & Salkeld 1983). In Chapter 5, I described a chain of alliances – starting with formal education and informal networks of enthusiastic hobbyists; then between Acorn Ltd., the manufacturer of the BBC Microcomputer, and the BBC series editors, producers and technicians; and then self-help publications, local computer clubs and magazines. The archive shows that this was an immensely successful network in creating a market for home computers and computer education (Blyth 2012). For a time 'learning' was specifically informal education where learners were self-enrolled, and where the architecture of technology was open to instruction (Tatnall 2012). I have argued that some of the indicators of this success have been drawn back into what

was expected of TEL researchers funded by the TEL Programme (2007-2012). This is a new way of looking at expectations of TEL research, and it illustrates that translations of past successes into public relations is a simplification of what was, and is still, a complex network of energies, talents and resources.

Another part of the discourse history of TEL research, another place *Where TEL research comes from,* was traced to business and industry (Chapter 5). It is common knowledge that TEL as a field of inquiry is also known as e-learning. I documented the origins of this term in the business-to-business industry of training in the workplace, what became known as the e-learning providers market. In the 1990s the terms 'learning' rather than education or training was adopted in business and industry as a signifier of 'output' from investment in human capital. The discourse of e-learning disseminates particular kinds of statements as common knowledge. For example, education was what workers did before employment, while training in the work place was costly but necessary. The network thrived on the productivity of marketing and advertising departments, and e-learning was offered as an object of desire, a lifestyle, and legitimised by alluding to origins in science and the academy. In practice e-learning was about improving business systems that were quantified in measures of efficiency, effectiveness, customer satisfaction and profitability. I argued that this discourse of systems engineering was translated back into TEL research by quasi-academic governmental organisations.

An effect of these linkages is that the discourse history of TEL research, that is *Where TEL research comes from,* can be described as an assemblage of networks focused on outcomes. In chapter 5 this was identified in connections between quangos and the academy. In the UK, a central node in these networks is partially funded quasi non-governmental organisations. Drawing on education policy archives, I described how relationships were consolidated in mutual commitments to 'evidence', 'relevance' and 'accessible knowledge'. I described how this discourse is persuasive in academic texts about TEL research as enacted mesh-up. On the one hand, these texts invoke authority and legitimacy for who is speaking and the centres of TEL excellence in which the work is located. On the other hand, persuasion is

subtle in pre-empting its critics. Published documents routinely insert predictable text related to risks and limitations. In this mesh-up, the black boxing of 'technology' and 'learning' has the rhetorical effect of persuading a large network that TEL research brings forth desirable outcomes. This was illustrated by analysis of public accounts of projects funded by the TEL Programme where 'learning' and 'technology' are taken as known categories, with the emphasis on 'enhancements' and the promise of outcomes. Examples are:

MiGen: … unlocking the mystery of generalisations to unlock the wonders of maths for 11–14 year olds with an intelligent microworld.

InterLife: … harnessing the power of 3D virtual words (Second Life™, Open Sim) to help young people develop social skills and navigate difficult transitions in their lives.

The socio-material construction of TEL research

In Chapter 6, I examined 'forms of ordering' as enactments that accommodate the mess of multiple constructions of 'technology', 'learning' and 'enhancement'. This demonstrated that TEL research is both coherent and non-coherent: coherent in persuading and meeting the expectations of a large network of interest, and non-coherent in the practices that counter these regimes. I found that constructions of 'enhancement' and 'TEL research' are routinely messy in mobilising multiple ontologies. At the same time coherent narratives were routinely present in public accounts of TEL research. This means that another, different kind of response to the question *Where does TEL come from?* is that it comes from the forms of ordering that make action possible. Chapter 6 described four forms of ordering as a way of understanding the productivity of how TEL research works, even when things don't fit, and to demonstrate the ambivalence of where TEL comes from and the work involved in enacting coherence. 'Knowing denial' is a form of ordering where TEL researchers are socialised into audit cultures while being encouraged by established researchers to recognise it as a 'necessary but not only'. 'Domestication moves' is where the pragmatic need to make sense is juxtaposed with loose ends that are

informally acknowledged. 'Persuasive packaging' is where coherence does not have to be rational when appealing to emotions and desire. 'Crafting conflict' is where non-coherence is ritualised in intellectual, political and scientific differences.

Together with the work on translation effects (Chapter 5), this work on forms of ordering (Chapter 6) is new in documenting TEL research outside the academy and how this has come back into funding regimes that construct what TEL research is.

Last words

I have indicated some ways in which the work in this thesis has contributed to new responses to the questions *What is TEL research?* and *Where does it come from?* This has drawn on particular literatures that were identified early in this Chapter ('Journey way markers'). There is no published literature on the discourse history of TEL research so the work in this thesis contributes in varying degrees to various separate bodies of knowledge. My concluding words summarise this, and speculate on the researchers' intentions, agency and the spaces that are opening up for imagining TEL new research.

This thesis contributes to the body of knowledge on *TEL as a field of inquiry* (for example Conole & Oliver 2007; Czerniewicz 2010; Laurillard 2002). Researchers working in TEL research and its feeder disciplines, such as computer science, cognitive science, and education studies, might be surprised by how their research has been examined as a discursive construction. The work in this thesis has demonstrated that TEL research has a discourse history that is dynamic, dispersed, and shaped by materials and social relations. This indicates that the successes and failures of TEL research are not qualities residing in the researchers or in the internal structure or essence of the field. This knowledge is an addition to the small but growing subset of TEL literature that is influenced by Foucault and / or actor-network theorists (for example Gorur 2012; Nespor 2012; Rimpiläinen 2012; Sorensen 2009). It is also an addition to the burgeoning research that draws on posthumanist sensibilities (Bayne 2015; Haxell 2008; Knox 2014; Thompson 2015)

which is a part of the field of TEL, sometimes at the margins but always 'eating away'[45] at its centre.

Scholars in fields such as science and technology studies – those interested in the work of Foucault, Latour and Law; and those who mobilise relational socio-material theories to study technology, design, learning or education policy – will find that the work in this thesis adds an archival study to the body of work in their networks, although this is admittedly a small drop in the ocean. The work in this thesis opens the possibility of TEL research connecting to more established bodies of Social Science knowledge that is about *Education, Science and Scholarship in the Digital Age* (Peters & Roberts 2012).

The last words in this thesis are 3 speculative comments. The first is about the researchers' intentions. If researchers' subjectivities are shaped by discourse in which truth is aligned to reason, evidence, and absolutes, then this thesis may be experienced as opaque, adversarial, even amoral. This is to be expected since Foucault, Latour and Law have also been criticised for being amoral. Like mine, their analyses does not start by assuming an unequal distribution of power and resources that needs to be rectified; or a defect, deficit, or breakdown that needs to be repaired; or even a problem that needs to be solved. However, I argue that the root impulse in their work (and mine) is a profoundly democratic one, imperfect though this may be in practice. The concepts mobilised here have a history of dismantling myths (Foucault 1991); of an even-handed interest in things big and small, human, material and semiotic (Latour 2005); and in the politics of engineering (Latour 1996; Law 1991). In line with these arguments, ways of knowing are negotiable by all sides and there is no absolute authority – neither God, nor Nature, nor Science – that can be called in to settle any disputes (Latour 2004). The normative insight from this is to entertain the possibility of negotiating new realities and understanding what it would take for these to be configured differently.

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[45] This phrase was suggested by Diana Mulcahy (External Examiners Report 2016)

The second speculative comment is about the agency of the researcher. I have argued that there is scope to think and study TEL research differently, not escape from it or abandon it. But the ambivalence experienced by researchers on the ground is real. The problem is that most current practices of disseminating research assume that findings can be reframed as generalised prescriptions or guidelines for practice. In contrast to this, there is a growing body of work which shows that differences, and different ways of enacting things, matter, be they guidelines, facts, bodies, a disease, software requirements, or research (Mol 2002; Ribes & Bowker 2005; Law 2004; Barry et. al 2008). Law (2004) advocates a form of counter-practice in which normativity is judged on a case-by-case basis and allowed to depend on context, location, commitments and other issues at hand. Mobilising these ways of doing and acting is, in my view, a worthwhile endeavour, but there is a danger that even this might be formalised into systems that lack transparency or accountability.

My final speculative point is a wish. I am imagining that TEL researchers have the capacity for forging new relations with some of the most exciting and influential research, and researchers, of our times. This has already started in relation to social science. I have made much of the new conceptual resources that have shaped what is possible to see and think about, and how this has come from interpreting Latour, Foucault and Law. In 2007, *Times Higher Education* ranked Latour as one of the most frequently cited book authors. Foucault ranks number 4 in the world in the webometrics citation index. Laws work continues to mobilise young researchers at the 'Centre for Research into Socio-Cultural Change' (www.cresc.ac.uk)   There is yet more scope for translations from Science and Technology Studies, Humanities and other disciplines. But perhaps the most interesting relationship I can imagine lies beyond the fruits of classical computing and the digital. After all, classical computing is only a small subset of computational possibilities; there are other possible materialisations and understandings of learning. For example, in relation to designing and learning complex systems, perhaps a radical rethink is in order. Why not grow technology? That's exactly what nature does with the worm, the weed and the bug. Both the opening quotes to this Chapter invoke this journey into the unknown. Non- classical computing (Stepney et al. 2005), and making new realities

(Law 2004) may sound like science fiction, but then again it is worth remembering that so did the Memex in 1945, the personal computer in 1970 and the web in 1994.

Appendix A

End Note 1

The shift to human-machine interactions that are more intimately co-dependent and about learning is evident in accounts of design research. For example, Douglas Englebart (1962) wrote about structuring knowledge to support the work of a wider range of experts: diplomats, executives, social scientists, life scientists, physical scientists, attorneys, and designers. Englebart and his research group designed futuristic dialogues between user and teacher. One of these appears in a report prepared for the US Air Force Office of Scientific Research and features an imaginary dialogue between a user and a technology:

> To try to give you (the reader) a specific sort of feel … by describing what might happen if you were being given a personal discussion-demonstration by a friendly fellow (named Joe) who is a trained and experienced user of such an augmentation system within an experimental research program …
>
> Joe understands this and explains that he will do his best to give you the valid conceptual feel that you want – trying to tread the narrow line between being too detailed and losing your over-all view and being too general and not providing you with a solid feel for what goes on. He suggests that you sit and watch him for a while as he pursues some typical work, after which he will do some explaining. (Engelbart 1962, p. 73)

These dialogues with Joe are interesting in their similarity to modern teaching with computers. There is a pedagogical attention to learning, with the emphasis on different point of view, levels of detail, simulation and graphic manipulation. Some of these forms of interacting with computers are so commonplace, they are taken for granted today. However, none of this was "practical in the research-lab sense until the 1960s, nor in the commercial sense until the 1980s [and many of the

technologies] were born/reborn several times within a half-century" (Boden 2006, p. 726).

End Note 2

In the 1960s psychologists Bruner and Miller were working on the relationship between representation of knowledge structures and learning (Hergenhahn 2008). Bruner and Miller claimed that pervasive systems of representation such as language, drawing and writing enter into the developing mind, shaping it as well as helping it learn. Taking this further Bruner (2009) writes: "There is a widespread and not unreasonable belief that we *should* be able to discover something about how to teach human beings more effectively from knowing how to program computers effectively" (p. 160 italics in the original).

Meanwhile, Minsky (1961) was writing about knowledge representation as crucial:

> It is usually necessary to have ways of assigning names to symbolic expressions – to the defined classes. The structure of the names will have a crucial influence on the mental world of the machine, for it determines what kinds of things can be conveniently thought about. (p. 13)

The primacy of representations is also seen in the work of Seymour Papert, who in the 1960s invited children into the labs at MIT to use the computer to write and to make graphics. In his book, *Mindstorms: Children, Computers and Powerful Ideas*, Papert (1980/1993) argued that children can learn to use computers in emergent ways, and that using computers can change the way everything else is learnt.

End Note 3

For example here are two of Foucault's starting points:

- The *History of Madness* (2001) is Foucault's early monograph first published in 1961. In this text Foucault begins by describing how since the middle ages

leprosariums and the cities of the damned systematically excluded madness from mainstream society. He then describes how by the middle of the 20th century, in art, literature and science madness was an object of fascination and pathologised as 'unreason' in need of treatment.

- *Discipline and Punishment* subtitled The *Birth of the Prison* (1995) was first published in 1975 and is an example of Foucault's later studies. In this text he begins by describing a public spectacle of torture and execution in 1757. He then quotes rules from a prison book on the routines of managing prisons. The book is about how the institution of the prison produces criminality and his analysis references movements that call for prison reform. A recurring theme in this analysis is that of 'discipline' as a specific historical form of power and knowledge.

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Appendix B

Appendix B: Table 1, Latour on uncertainty and constructions

Concepts from *Reassembling the Social*, Latour (2005)

First Source of Uncertainty: No Groups only Group Formations (pp. 27- 42)	Examples of Inferred questions and methods notes
Groups delineate boundaries by describing outsiders. (p.32)	What groups are recognised as doing TEL research? (Consider e.g. Organisations, research centres, funded projects, courses/programmes, journals, conferences, national and international programmes.)
Groups have spokespersons. (p.31)	Who speaks for these groups?
There exists endless ways of rending groups as definite and sure so that it looks like an unproblematic definition. (p.33)	How are the group boundaries consolidated as unproblematic? How are researchers allocated to groups or identify themselves as part of a group? What movement between groups is permitted, or discouraged, made difficult or discouraged or simply not possible?
Spokes persons that make the group durable include all kinds and manner of scientists and instruments of research. (pp. 33-34)	What groups of scientist and instruments are enrolled and where? (Consider e.g. peer reviewed publications, grey literature like blogs, presentations, and podcast lectures and discussions forums.)
Second Source of Uncertainty: Action Is Overtaken (pp. 43 – 62)	Examples of Inferred questions and methods notes
-"…agencies are always presented as doing something that makes a difference to a state of affairs, transforming some As into Bs through trials with Cs." (pp. 52-53)	What is the 'state of affairs' that need 'transformation'? Does this change over time? What form does this accountability take e.g. what is promised, made, demonstrated, and audited?
Actors engage in criticizing other agencies as fake, archaic and so forth. (pp. 56-57)	What/where are the competing entries and relations? Where are the traces of conflict? What are the conflicts about?
Actors have their own theories of action to describe and explain agency (p. 57)	What justifications are recurring e.g. making a difference, social justice, innovation, competitive work force, equality and equality, and personalised learning?

Third Source of Uncertainty: Objects too Have Agency (pp. 63-86)	**Examples of Inferred questions and methods notes**
…study innovation in the artisan's workshop, the engineer's design department ….users home. (p. 80)	Where are the accounts and prototypes which are from the period when computers in education were not taken for granted i.e. experimental, fragile and uncertain?
….even the most routine, traditional and silent objects stop being taken for granted with distance e.g. distance in time (archaeology), distance in space (ethnology), and distance in skills (learning is lost or there is a gap). (p. 80)	Can the objects be made to 'talk' by writing accounts of logics in the software. Examine data for distances e.g.: distance in time – write accounts of discourse beginnings and translations; distance in space – look for how discourse is transported in the machine, and look for distance where things don't work or breakdown.
…look at conditions of breakdown e.g. accident, breakdown, strike, crisis. (p. 81)	Are these aspects of TEL research that have been silenced or broken down? Was there new products, knowledge and learning outside the academy?
….when object recede bring them back with archives, documents, memoirs, museum collection etc. to artificially produce the historians account of the state of crisis in which machines, devices and implements are born (p. 81) Write these accounts to recognise the plasma of unconnected things that escape and may be connected later in unexpected ways.	Construct composite accounts that narrate themes and patterns which are distributed across different versions of software and computer hardware and technologies which are about 'knowledge', 'learning' and 'pedagogy'. Include things that don't fit, i.e. things that are contradictory , competing or rendered invisible. Do the same for constructions of 'learning' and 'enhancement'. Recognise and document things that are non-coherent.
Fourth Source of Uncertainty: Matters of Facts and Matters of Concern (pp. 87-120)	**Examples of Inferred questions and methods notes**
-"the great advantage of scientific facts is that … they are fabricated, they exist in many different shapes and at very different stages of completion" it is only later that these are hidden" (p. 118)	Go back to laboratories and research institutes and follow the facts in the making e.g. theories of learning, software routines and configurations of TEL. How did the move from analogue to digital take place? Where was this made public and how was it taken up? Where did the internet and the world wide web come from?
"The material infrastructure provides everyday more proof of a precise follow up of associations, as any look at the World Wide Web turned World Wide Lab shows" (p. 119)	Beyond the laboratories and academy look for other places of (pre) TEL research e.g. in commerce and hobbyist communities and mass media and BBC archives. Where were the machines? What else was assembled around the digital technology and where?

The very organisation of research, grant applications, programme, publications, policy, peer review etc. offers analyst sources of information on how to raise the question of ontology. (p. 119)	Data collections could be organised around discursive shifts in what is regarded as important and worth funding and this can be traced in (1) the source and location of funding; (2) shifting themes of special editions of TEL journals; (3) media reporting; and (4) policy documents and speeches.
"While before you could go back and forth between reality and fiction as if it was the only road worth taking, it is now possible to distinguish the procedures allowing for realities - now in the plural -and those leading to stability and unity" (p. 119)	Following traces of uncertainty will throw up plural (coexisting) forms of stability – this ambivalence is part of the account of – what is TEL research and where it comes from. *Law's work on non-coherence has more to say about writing accounts of multiplicity (2004)*
Fifth Source of Uncertainty: Writing Risky Accounts (pp. 121-140)	**Examples of Inferred questions and methods notes**
-"The best way to proceed at this point and to feed off the fifth source of uncertainty is simply to keep track of all our moves, even those that deal with the very production of the account….because from now on *everything is data*." (p. 133)	Everything is data but to treat everything as data when the source is the internet needs some strategic simplifications i.e. criteria / rationale for organising the data into collections. This can be linked to Foucauldian concept of 'historical interruptions'.
"it might be useful to list the notebooks one should keep" and "I am using the notebook rather metaphorically since they now include digital files as well as films, interviews and websites."(p. 134)	The notebooks (in this thesis) are files and folders in the qualitative research tools called NVivo 10. This is proprietary software so I need to find a way to preserve the data and also make it possible to navigate the collections with future readers in mind.
Log of the inquiry itself…. who was met, what sources accessed, at precise dates and times (p. 134)	Design a meta data file to log each item of data its source and other attribute information. The attributes need to be specified and adjustable as the analysis progresses.
Notebook to keep the information in such a way to simultaneously see chronology and themes (p. 134)	Log the themes as they emerge and are concatenated, extended or and in other ways changed.
Notebook on ad libitum writing i.e. a record of ideas during the study. (p. 134)	Diary of researchers reflections
Notebook to register the effects of the written account on the actors ....(pp. 134-5)	Noting the effects of making data selection, and strategies for writing 'findings' in a way that are clear and fit into the remit of a PhD thesis.

Rendering associations traceable again (pp. 159 -219)	Examples of Inferred questions and methods notes
First Move: Localizing the Global. "whenever a well ordered pecking order between scales has been staged…" (190) ask questions about where did this come from, what are the instruments and costs, and who manages the process. The injunction is "don't jump" (p. 190)	The Vantage point - What is TEL research in the TEL call for funding documents (2006, 2007)?What is being gathered? How is the assemble of what is 'technology', 'enhancement' and 'learning' evident? What work is going on to make this persuasive? Find a way to trace how the global is localised at the vantage point i.e. in the TEL call documents and in the events around the launch of the TLRP-TEL Programme in the UK.
Second Move: Redistributing the Local. "Whenever the urge to go away from local interaction manifested itself, and instead of trying to some *salto mortale* towards the invisible rear-world of the social context, I proposed to trudge towards the many local places where the global, the total and the structural are being assembled and where they expand outwards…" (p.191 italics in the original)	Where are the effects in construction of 'technology', 'learning' and 'enhancements' as stabilised at the vantage point? What are the effects of discourse in the TEL call documents looking forward into the TEL Programme events and publications?

Where there is talk of totality, the general, the structural and truth – how does this work at the local in the materials in the archive? |
| Third Move: Connecting Sites refer back to 17-22 in this table work out how to write, and present findings. Ideas: bricolage, composite accounts, and annotated diagrams. | What does this add to understanding TEL research in different ways and writing a discourse history of TEL. How does it relate to Foucault (2002) and Law (2004)? |

Appendix. A: Table 2, Foucault on discourse and regularities

Concepts from Foucault's method in *The Archaeology of Knowledge***, Foucault (2002).**

1. On the **"Unites of Discourse"** (p. 23) Foucault writes that the first stage of analysis is the "negative work" (p.23) of disrupting taken-for-granted, familiar and immediate groupings, themes, theories, and received forms of history and knowledge work.

2. On **"Discursive Formations"** (p. 34) Foucault acknowledge that initially analysis makes "indiscriminate use ….of the term statement, event, and discourse" (p. 34), and that it is difficult to know "the relations that may legitimately be described between statements that are left in their provisional, visible groupings." (p.34). Discursive formations different across domains and historical epochs but never-the-less are recognisable as discourse and regularities.

3. On the **"Formation of Enunciative Modalities"** (p. 55) Foucault links together quite disparate phenomena? E.g. in the discourse of nineteenth century doctors: "Qualitative descriptions, biographical accounts, the location, interpretation, and cross-checking signs, reasoning by analogy, deduction, statistical calculations, experimental verifications …." (p. 55). Enunciate modalities are regularities that make quite diverse statements persuasive, and productive.

4. On **"Formation of the Object"** (p. 44) Foucault writes "We must now list the various directions that lie open to us, and see whether this notion of 'rules of formation' ….can be given content." (p. 44).

5. On the **"Formation of the Concept"** (p. 62) Foucault advocates close analysis that describes "the organisation of the field of statements where they appeared and circulated." (p. 62).

6. On the **"Formation of Strategies"** (p. 71) Foucault writes: "Such discourses….give rise to certain organisations of concepts, certain regroupings of objects, certain types of enunciations …… Whatever their formal level may be, I shall call these themes and theories 'strategies'."(p.71)

The formation of enunciative modalities (p. 55)	**Examples of Inferred questions**
"….who is speaking? Who, among the totality of the speaking individuals, is accorded the right to use this sort of language (…)*?* Who is qualified to do so? Who derives from it his own special quality, his prestige, and from whom, in return, does he receive if not the assurance, at least the presumption that what he says is true?" (p. 5)	What are the unites across statements in which the author is named, characterised and authorised? When and where is the author more than one, e.g. a funding body, or a professional association? What work is involved in constructing the authority and legitimacy of TEL research? Who is allowed to speak about TEL research? Who listens?

"We must also describe the institutional sites from which….. the discourse derives its legitimate source and point of application (its specific objects and instruments of verification)?" (p. 56)	What are the institutional and organisational sites of TEL research? Is the material published by these organisations archived? Where are the 'legitimate' sources of TEL material? How is the internet mobilised as an 'institutional' site and what are the regularities involved?
"The position of the subject are also defined by the situation that it is possible …. to occupy in relation to the various domains or groups of objects: according to a group of explicit or implicit interrogations, he [sic] is the questioning subject; according to a table of characteristics feature, he [sic] is the seeing subject, and according to a descriptive type, the observing subject…" (pp. 57-58)	What text, symbols, and objects and institutions produce TEL subjects? Where are the statements from these 'text', 'symbols' and 'objects'. Where are the statements about disciplined subjects and subjectivities? How are these productive in constructions of 'technology', 'enhancement', 'learning' and 'research'? What different clusters of regularities characterise the discourse history of TEL research.
Discourses are: "manifest in dispersion……It is a space of exteriority in which a network of distinct sites is deployed." (p.60)	How are discourses of TEL research reproduced, carried, transported across time and geographically? What is left out, invisible, 'unspeakable'?
The formation of the object (p. 44)	**Examples of Inferred questions**
Map the surface of emergence but "these are not the same in different societies, at different periods, and in different forms of discourse" (p. 45). "We must also describe authorities….and analyse the grid of specification according to… [*how things are*]… divided, contrasted, related, regroups, classified, derived from one another..." (p. 46, *italics added*)	How are statements organised to make material design, and certain kinds of knowledge possible? What regularities are involved across production of technologies, images, terms, phrases, ordering and classifications? What rules are discernible across sites where TEL research is said to take place? How are boundaries of TEL research produced by regularities?
" Unity of discourse is based not so much on the permanence and uniqueness of the object as on the space in which various objects emerge and are continuously transformed." (p. 36)	When groups of statements refer to an object, the object will not be the same object once and for all, describe the differences? How are differences accommodated in the interplay of rules?

The formation of the concept (p. 62)	**Examples of Inferred questions**
"Could a law not be found that would account for the successive or simultaneous emergence of disparate concepts ….but not as a virtual deductive edifice ….but more like describing the organisation of the field of statements where they appeared and circulated." (p. 62)	Which concepts circulate in talk about education and learning? How do concepts from learning theory get enacted in technology design? What concepts from technology design are drawn into descriptions of learning? What regularities describe these circulations and translations?
"Distinct from a field of presence one may also describe a *field of concomitance* (this includes statements that concern quite different domains of objects, …. and include quiet different types of discourse, but which are active among the statements studied here…." (p. 64, *italics in the original*)	Where are statements about 'technology' and 'learning'? Where and when is there talk of 'enhancement'? What regularities are active in different historical, geographic sites and knowledge domains and how does this construct 'TEL research' ? What is bought together, left out, and what gets added along the way?
"Procedures of intervention that can be legitimately applied to statements… these may appear as *techniques of rewriting*, ….*modes of translation*, …..means used to increase the *approximation* and refine their exactitude,….the way in which one *delimit* …. - by extension or restriction the domain of validity of statement…" (p. 65, *italics in the original*)	What are the TEL research themes? Where do they come from and how are these validated? What are the techniques of rewriting and modes of translation across knowledge domains (e.g. computer science and engineering)? How does delimiting work to include and exclude what counts as valid TEL research? What regimes of truth prevail and how are these changed over time?
The formation of the strategies (p. 71)	**Examples of Inferred questions**
"Such discourses….give rise to certain organisations of concepts, certain regroupings of objects, certain types of enunciations …… Whatever their formal level may be, I shall call these themes and theories 'strategies'. (p.71) Determine diffraction of discourse, where objects and concepts are regarded as incompatible; and then characterised in equivalent terms, and systematically come to form discursive subgroups, alternatives and oppositions rather than a "defect of coherence" (p. 73)	What themes and theories characterise the shifts in the discourse of TEL research? How are these materially embodied in software design, in hardware, in commercial events and in the structure of organisations? What strategies produce the objects and concepts of 'learning' and 'the learner'. What are the subgroups, alternatives, and oppositions and what regularities make these part of the same TEL discourse.

| "Determine the possible *point of diffraction* of discourse. These points are characterised as *points of incompatibility* - where .. objects .. enunciations, or concepts may appear, in the same discursive formation, without being able to enter … the same series of statements. They are then characterised as *points of equivalence*, the incompatible elements …appear in the form of 'either or'. Lastly they are characterised as *link points of systematization….*" (p. 73, *italics in the original)* | What are the points of diffraction in TEL research? What objects and concepts are part of the same discursive formation but regarded as incompatible? What are the rules of engagement in forming alliances and characterising opponents? How are alternatives presented – look for rhetorical tactics e.g. circular argument, false opposites, appeal to emotion, appeal to authority, status, and history, When and where does 'invoking equivalence', and the work of 'systematization' give rise to discursive subgroups and larger discursive shifts. |

Appendix. A: Table 3, Law on coherence and non-coherence

Concepts from *After Methods: Mess in Social Science Research*, **Law (2004)**

Metaphors for Investigating knowledge practices:
(1) The hinterland of science knowledge practices.

 "If realities 'out-there' and new knowledge of those realities 'in here' are to be created than practices that can cope with a hinterland of pre-existing social and material realities also have to be built up and sustained. I call enactment of this hinterland and its bundles of ramifying relations a 'method assemblage.'" (p. 13)

Metaphors for Investigating knowledge practices:
(2) Gathering, fractional accounts and fluid results

  Fractionality: " a metaphor for expressing the idea that objects, subjects and realities (and so their hinterland) are more than one and less than many. The idea that hinterlands partially intersect with one another in complex ways." (p. 160)
 "the 'out-there' realities reflected in those in-here statements "endless ramifications of processes and contexts 'out there' that are both necessary to what is 'in-here' and invisible to it." (p. 42)
Gathering: "a metaphor like that of bundling in the broader definition of method assemblage. It connotes the process of bringing together, relating, picking, meeting, building up, or flowing together, It is used to find a way of talking about relations without locating these with respect to the normative logics implied in (in)coherence or (in)consistency." (p. 160)

Metaphors for Investigating knowledge practices:
(3) Multiple worlds and different sites

"But do these practices narrow down, converge, to make a single reality? …different practices produce not only different *perspective*, but also different *realities"* (p. 13, *italics in the original*)
Multiplicity: " like differences, the simultaneous enactment of objects in different practices, when these objects that are said to be the same. Hence the claim that there are many realities rather than one. This arises because practices are endlessly variable and differ from one another. The additional claim that practices overlap in many and unpredictable ways, so there are always interferences between different realities. Multiplicity is inconsistent with singularity, but also with pluralism." (p. 162) See also Latour uncertainty Appendix B, table 2.

Metaphors for Investigating knowledge practices:
(4) Modes of ordering / logics

Modes of ordering work to regulate differences that are in effect concurrent and mutually interfering practices: "There are many ways of reconciling differences and avoiding multiplicity…they work to push the possibility of multiplicity of the agenda." "We discover multiplicity, *but not pluralism.* For the absence of singularity does not imply that we live in a world composed of ….indefinite [possibilities] .that reality is fragmented." (p. 61, square brackets added)

Examples of Inferred questions

What is being gathered from the hinterland of where TEL comes from (i.e. discourse history)?

What is taken-for-granted, common knowledge, black boxed, simplified, reduced, and hidden? Account for differences in depictions of the 'real'.

What different histories are compounded into coherence.

What knowledge practices are enrolled and how are these same and different?

How do the different paradigms connect or partly connect?

How does this 'work' in action.

How do accounts of TEL research translate each other?

How do statements relate to what is being claimed about realities. What happens to contradictions?

Look for how this 'works' in specificity of what is taken-for-granted, common knowledge, black boxed, simplified, reduced, and hidden. What is being gathered to make TEL knowledge practices possible and recognisable?

Write composite accounts that describe different realties that are entangled in the same materials?

How are objects like 'learning', 'technology' and 'enhancement' enacted across different sites of TEL research. What forms of data analysis can trace enactments at different archival sites. Can composite accounts capture differences and simultaneous enactments of sameness?

How do differences work so that they are routinized, unsurprising expected part of the discourse, and regime of truth?

What are the forms of ordering that help make TEL research recognisable as a field of inquiry?

What are the modes of ordering that allow coherence and non-coherence to co-exist in practice?

What are the normative choices? Is it possible to make new realities or is the point to unsettle and interfere?

How can this ambivalent form of analysis produce 'new knowledge' and why does it matter?

References

Abrami, P. C., Bernard, R. M., Wade, C. A., Schmid, R. F., Tamim, R., Surkes, M., Peretiatkowicz, A. 2006 , 'Review of E-Learning in Canada: A Rough Sketch of the Evidence, Gaps, and Promising Directions', *Canadian Council on Learning, Centre for Study of Learning and Performance*, Concordia University, Montreal.

Alexander, S., Harper, C., Anderson, T., Golja, T., Lowe, D., McLaughlan, R., Schaverien, L. & Thompson, D. 2006, 'Towards a mapping of the field of e-learning', in E. Pearson & P. Bohman [eds.], *Proceedings of EdMedia: World Conference on Educational Media and Technology 2006* (pp. 1636-1642). Association for the Advancement of Computing in Education (AACE).

Allen, D. & Albury, R. 1980, *Micorelectronics*. BBC Education, London.

Anderson, J. H. 1992 , 'Connecting voices: feminist pedagogy and hypertext.' Paper presented at the meeting of the *American Educational Research Association*. San Francisco, CA, 2nd April.

Anderson, J. H., & Damarin, S. K. 2001, 'Poststructural Feminism and Research in Educational Communications and Technology', In *The Handbook of Research for Educational Communications and Technology* AECT, Washington US. pp. 19 – 25.

Andrews, R. N. L., Haythornthwaite, C., & Laythornethwaite, C. [eds.] 2007, *THE SAGE Handbook of E-learning Research*, Sage Publications Ltd., London.

Aristotle 1954 , *Rhetoric*, trans. W. R. T. Roberts, Random House, New York.

Atktin, K. C. & Rice, R. E. 2013, Theory and Principles of Public Communication Campaigns. Public Communication Campaigns, 4th edn, Sage Publications, London.

Attwell, G. & Hughes, J. 2010, *Pedagogic approaches to using technology for learning: Literature review*, Lifelong Learning UK, viewed 9 November 2015, <http://dera.ioe.ac.uk/id/eprint/2021>

Balacheff, N., 2007, *10 issues to think about the future of research on TEL. A Kaleidoscope collective working paper,* Les Cahiers Leibniz, viewed 9 November 2015, < https://telearn.archives-ouvertes.fr/hal-00190343>

Balacheff, N., Ludvigsen, S., de Jong, T., Lazonder, A. & Barnes, S. 2009, *Technology-Enhanced Learning Principles and Products*, Springer Netherlands.

Bamasag, O. 2015, 'On the enhancement of teaching method for information security course', *International Journal of Technology Enhanced Learning*, vol. 7, no. 1, pp. 36–43.

Banks, S., Goodyear, P., Hodgson, V., & McConnell, D. 2003 , 'Introduction to the special issue on Advances in Research on Networked Learning', *Instructional Science*, vol. 3, no. 1, pp. 1-6.

Barnet, B. 2008 , 'The Technical Evolution of Vannevar Bush's Memex', *Digital Humanities Quarterly*, vol. 2, no.1, viewed 9 November 2015, <http://www.digitalhumanities.org/dhq/vol/2/1/000015/000015.html#nyce1991>

Barnet, B. 2010 , 'Crafting the User-Centered Document Interface: The Hypertext Editing System HES , and the File Retrieval and Editing System FRESS', *Digital Humanities Quarterly*, vol. 4, no. 1, pp. 4457.

Barry, A., Born, G. & Weszkalnys, G. 2008 , 'Logics of interdisciplinarity' *Economy and Society*, vol. 37, no. 1, pp. 20-49.

Bates, A. W. 2005 , Technology, e-learning and Distance Education Routledge Studies in Distance Education, 2nd edn, Routledge, Abington England.

Baudrillard, J. 1991, 'The precession of simulacra', trans. P. Foss & P. Patton, in D. Hlynka & J. Belland [eds.], *Paradigms Regained: The Uses of Illuminative, Semiotic, and Post-Modern Criticism As Modes of Inquiry in Educational Technology*, Englewood Cliffs, New Jersey, pp.441-80.

Bayne, S. 2015, 'What's the matter with 'technology-enhanced learning'?', *Learning, Media and Technology*, vol. 40, no. 1, pp. 5–20.

Bazeley, P., & Jackson, K. 2013, *Qualitative Data Analysis with NVivo*, Sage Publications, Los Angeles.

BBC video of Tony Sale talking about the Colossus 2010, BBC documentary News Channel, viewed 29 November 2015 <http://news.bbc.co.uk/1/hi/technology/8486345.stm>

Beetham, H. 2004, *Review: developing e-learning Models for the JISC Practitioner Communities*, Online: JISC resources, viewed 10 April 2009, <http://www.elearning.ac.uk/elearningandpedagogy/peddesign/emodels/emodels/>

Beetham, H. 2005, e-Learning research: Emerging issues. *ALT-J, Research in Learning Technology*, vol. 13, no. 1, pp. 81-89.

Beetham, H., Jones, S., & Gornall, L. 2001, *Career Development of Learning Technology Staff: Scoping Study Final Report*, commissioned by JISC Committee for Awareness, Liaison and Training Programme, viewed 9 November 2015, <http://www.jisc.ac.uk/publications/publications/cdssfinalreport.aspx>

Berners-Lee, T. 1997, 'World-wide computer', *Magazine Communications of the ACM,* vol. 40, no. 2, pp. 2-3.

Berners-Lee, T. 1989, *Information Management: A Proposal*, commissed by CERN, Geneva, archived by W3 archive online, viewed 9 November 2015, <http://www.w3.org/History/1989/proposal.html>

Berners-Lee, T. 1996, 'WWW: Past, Present, and Future', *Computer*, vol. 29, no. 10, pp. 69-77.

Berners-Lee, T. 2000, Weaving the Web: The Original Design and Ultimate Destiny of the World Wide Web, HarperCollins Publishers Inc., New York.

Bernstein, B. 2000, *Pedagogy, Symbolic Control and Identity Critical Perspectives,* Rowman & Littlefield Publishers, Oxford England.

Bichelmeyer, B. 2004 , *The ADDIE Model - a metaphor for the lack of clarity in the field of IDT.,* Indiana University Future Group AECT., viewed 9 November 2015, <http://www.unco.edu/cetl/sir/clt/documents/IDTf_Bic.pdf>

Biesta, G. 1998, 'Pedagogy without Humanism: Foucault and the Subject of Education', *Interchange*, vol. 29, no. 1, pp. 1–16.

Biesta, G. 2005, 'Against Learning. Reclaiming a language for Education in an age of Learning.', *Nordisk Pedagogik*, vol. 25, no. 1, pp. 54–66.

Biesta, G. 2008, 'Encountering Foucault in Lifelong Learning', in A. Fejes & K. Nicoll (eds),*Foucault and Lifelong Learning. Governing the subject*, 1st edn, Routhledge Tayor & Francis Group, London and New York, pp. 193–225.

Biesta, G. 2008, 'Encountering Foucault in Lifelong Learning', in A. Fejes & K. Nicoll [eds.], *Foucault and Lifelong Learning. Governing the Subject,* Routhledge Tayor & Francis Group, London, pp. 193-225.

Bishop, L. 2008 , 'Constructing and Deconstructing a Digital Data Archive', *The Ontology of the Archive Conference,* University of Manchester, UK 25 April 2008, University of Manchester, ReStore repository.

Bitzer, D. L. 1988, *Oral history interview with Donald L. Bitzer conducted by S. Hocheiser 19 February 1988*. Charles Babbage Institute, viewed 9 November 2015, <http://umedia.lib.umn.edu/node/89823>

Bizer, C., Heath, T., & Berners-Lee, T. 2009, 'Linked Data - The Story So Far, *International Journal on Semantic Web and Information Systems*, vol. 5, no. 3, pp. 1-22.

Bizmedia Academy Internet 2002, *E-Learning here & now,* January, p.19.

Blunkett, D. 2000, 'Influence or irrelevance: can social science improve government?', *Secretary of State's Economic and Social Research Council Lecture*, ESRC Council / Department of Education and Employment, London , 2 February.

Blyth, T. 2012, *The Legacy of the BBC Micro Effecting Change in the UK's Culture of Computing*, Nesta, viewed 9 November 2015, <https://www.nesta.org.uk/sites/default/files/the_legacy_of_bbc_micro.pdf>

Boden, M. A. 2006, *Mind As Machine: A History of Cognitive Science, Volume 1*, Oxford University Press, Oxford, UK.

Bowker, G. C., & Star, S. L. 1996 , 'How things (actor-net) work: Classification, magic and the ubiquity of standards. *Philosophia*, vol. 25, no. 3-4, pp. 195-220.

Bowker, G. C., & Star, S. L. 2000, *Sorting Things Out: Classification and Its Consequences*, The MIT Press, Massachusetts.

Braidotti, R. 2013, *The Posthuman*, Policy Press, Cambridge, UK.

Brand, S. 1968, *Whole Earth Catalog*, Whole Earth Catalog Family of Publications, viewed 9 November 2015, <http://www.wholeearth.com/issue-electronic-edition.php?iss=1010>

Briggs, A. 1995, The History of Broadcasting in the United Kingdom: Volume V: Competition, OUP Oxford, Oxford UK.

Brookfield, S. 1985, 'Self-directed learning: A critical review of research,' in S. Brookfield [ed.], *Self directed learning: Theory to practice. New Directions for Continuing Education, No. 25.*, Jossey-Bass, San Francisco, CA, pp. 1–16.

Brooks, F. B. 1995, *The Mythical Man-Month*. Addison-Wesley, Indiana.

Brugger, N. 2005, *Archiving Websites General Considerations and Stratagies*, Center for Internet Internet Research, Denmark, viewed 9 November 2015, <http://cfi.au.dk/fileadmin/www.cfi.au.dk/publikationer/archiving_underside/archiving.pdf>

Bruner, J. 2009, 'Culture, mind, and education', in K. Illeris [ed.], *Contemporary Theories of Learning. Learning theorists… in their own words,* Routhledge Tayor & Francis Group, London, pp. 159-168.

Bryman, A. 2012 , *Social Research Methods*, Oxford University Press, Oxford.

Bryson, M., & de Castell, S. 1994, 'Telling Tales out of School: Modernist, Critical and Postmodern stories about Educational Technology', *Journal of Educational Computing Research*, vol.10, no3, pp.199-221.

Buchanan, B. G. 2006, A Very Brief History of Artificial Intelligence. *AI Magazine*, vol. 26, no. 4, pp. 53-60.

Buckingham, D. 2007, *Schooling the Digital Generation: Popular Culture, the New Media and the Future of Education* (Inaugural Professorial Lecture), Institute of Education Press, London.

Burke, C. 1994, *Information and Secrecy : Vannevar Bush, Ultra, and the Other Memex*, Scarecrow Press, Lanham, MD.

Burton, A. 2006, *Archive Stories: Facts, Fictions, and the Writing of History*, Duke University Press, US.

Bush, V. 1945, 'As We May Think', *The Atlantic Magazine*. July, viewed 9 November 2015, <http://www.theatlantic.com/magazine/archive/1945/07/as-we-may-think/303881/>

Bush, V. 1995, As We May Think. *Journal of Electronic Publishing*, vol. 1, no. 2. pp. 112-124.

Bush, V.1970, *Pieces of the action*, William Morrow, New York.

Callon, M 1986, 'Some Elements of a Sociology of Translation: Domestication of the Scallops and the Fishermen of St Brieuc Bay', in J. Law [ed.], *Power, Action and Belief: A New Sociology of Knowledge*, Routledge & Kegan Pau, London, pp. 196-233.

Callon, M. 1991, 'Techno-Economic Networks and Irreversibility,' in J. Law (ed.), *A Sociology of Monsters: Essays on Power, Technology and Domination*, Routhledge, London, pp. 132–61.

Callon, M. 1998, The Laws of the Markets / Sociological Review Monogrpahs, Wiley, UK.

Campbell-Kelly, M., Aspray, W., Ensmenger, N., & Yost, J. R. 2013, *Computer: A History of the Information Machine,* 3rd edn, The Perseus Books Group, Boulder US.

Card, S. K., Moran, T. P., & Newell, A. 1983, *The Psychology of Human-Computer Interaction*, Taylor & Francis, US.

Carmichael, P. 2011, *Networking Research: New Directions in Educational Enquiry*, Continuum International Publishing Group - Academi, London and New York.

Carmichael, P., & Patel, U. 2007, *Semantic Technologies for the Enhancement of Case Based Learning*, respone to TEL call for funding ESRC/EPSRC 2007, document RES-139-25-0403, viewed 9 November 2015, <http://www.uts.edu.au/sites/default/files/ensemble_caseforsupportwebsite.pdf >

Carr-Chellman, A. A. 2004, 'Instructional systems, learning sciences, design, technology: A more complete pathway', *Educational Technology*, vol. 44, no. 3, pp. 40-44.

Carroll, J. M. 2003, HCI Models, Theories, and Frameworks: Toward a Multidisciplinary Science, Morgan Kaufmann, Amsterdam, Boston MA.

Cetina, K. K. 2009, *Epistemic Cultures: How the Sciences Make Knowledge*, Harvard University Press, Cambridge Massachusetts.

Chan, T.-W. 2006, 'One-to-one Technology-Enhanced Learning: an opportunity for Global Research Collaborations', *Research and Practice in Technology Enhanced Learning*, vol. 1, no. 2, pp. 3–29.

Chappell, C., Rhodes, C., Solomon, N., Tennant, M., & Yates, L. 2003, *Reconstructing the Lifelong Learner*, Routhledge-Falmer, London.

Chappell, C., Solomon, N., Tennant, M., Williams, C., & Yates, L. 2005, *Changing work, changing workers: pedagogies of the new vocationalism*, ACADEMIA online, viewed 9 November 2015 <https://www.academia.edu/2314826/Researching_the_pedagogies_of_the_new _vocationalism>

Chen, L. & Lien, Y. 2011, 'Using author co-citation analysis to examine the intellectual structure of e-learning: A MIS perspective', *Scientometrics*, vol. 89, no. 3, pp. 867-886.

Chen, N., Wei, C., & Chen, H. 2008, 'Mining e-Learning domain concept map from academic articles', *Computers & Education*, no. 50, no. 3, pp. 1009-1021.

Chirgwin, R. 2013, 'Computer are irrelevant to education outcomes, says US study,' *The Register*, 21May 2013.

Chomsky, N. 1967, 'A Review of B. F. Skinner's Verbal Behavior', in L. A. Jakobovits & M. S. Miron [eds.], *Readings in the Psychology of Language,* pp. 142-143.

Chomsky, N. 2006, *Language and Mind,* 3rd edn, Cambridge University Press, Cambridge, UK.

CloserStill 2014, *CloserStill strengthens learning sector portfolio with acquisition of Bizmedia Ltd.*, Training Press Release, London.

Coffield, F. 2007, *Running Ever Faster Down the Wrong Road: An Alternative Future for Education and Skills* (Inaugural Professorial Lecture), Institute of Education Press, London.

Coffield, F. 2000, *Differing visions of a learning society, Research Findings, Vol. 1*, Polity Press, Bristol.

Collins, A. & Halverson, R. 2010, 'The second educational revolution: rethinking education in the age of technology', *Journal of Computer Assisted Learning*, vol. 26, no.1, pp.18-27.

Conole, G. & Dyke, M. 2004, 'Discussion Understanding and using technological affordances: a response to Boyle and Cook' . *Alt-J, Research in Educational Technology*, vol.12, no.3, pp.301-308.

Conole, G. 2004, 'E-Learning : The Hype and the Reality', *Journal of Interactive Media in Education*, *11*, viewed 9 November 2015, < http://www-jime.open.ac.uk/articles/10.5334/2004-12/>

Conole, G., & Oliver, M. 2007, Contemporary Perspectives in E-learning Research: Themes, Methods And Impact on Practice, Routledge Taylor & Francis Group, Abindon, Oxon.

Cook, J., & Noss, R. 2010, *Technology in learning. A response to some questions from the Department of Business Innovation and Skills*, ALT Open Access Repository, viewed 9 November 2015, < http://repository.alt.ac.uk/839/>

Corti, L., & Backhouse, G. 2005, 'Acquiring Qualitative Data for Secondary Analysis', *Forum: Qualitative Social Research*, vol. 6, no. 2, art. 36 May.

Coutinho, C., & Gomes, M. J. 2006, 'Critical Review of Research in Educational Technology in Portugal', in E. Pearson & P. Bohman [eds.], *Proceedings of EdMedia: World Conference on Educational Media and Technology AACE,* Orland: pp. 2679-2686.

Crook, C., & Harrison, C. 2008, 'Web 2.0 technologies for learning at Key Stages 3 and 4: a Summary Report'. *BECTA September*, September 2008, pp.1-46.

Cross, J. 2008, 'Origins of e-Learning', *Internet Time Blog*, viewed 9 November 2015, <http://www.internettime.com/2008/11/origins-of-elearning/>

Czerniewicz, L. 2008, 'Distinguishing the Field of Educational Technology', *Electronic Journal E-Learning*, vol. 6, no.3, pp.171-178.

Czerniewicz, L. 2010, 'Educational technology - mapping the terrain with Bernstein as cartographer', *Journal of Computer Assisted Learning*, vol. 26, no.6, pp. 523-534.

Czerniewicz, L., Ravjee, N., & Mlitwa, N. 2006, *ICTs and the South African higher Education Landscape*, ICTs and the South African Higher Education Landscape, Research report, viewed 9th November 2015 < https://halshs.archives-ouvertes.fr/hal-00190317/document>

Dahaene, S. 1997, *The Number Sense: How the Mind Creates Mathematics*, Oxford University Press, Oxford.

Davies, D. 2002, 'Learners and Learning: Lessons to be Learned', *Widening Participation and Lifelong Learning*, vol. 4, no.1, pp 2-4.

Davies, P. 1999, 'What is Evidence-based Education?,' *British Journal of Educational Studies*, vol. 47, no. 2, pp. 108–21.

Dawson, K., & Ferdig, R. E. 2006, 'Commentary : Expanding Notions of Acceptable Research Evidence in Educational Technology: A Response to Schrum et al.', *CITE Journal Contemporary Issues in Technology and Teacher Education*, vol. 6, no.1, pp. 133-142.

de Laat, M., Lally, V., Simons, R. E., & Wenger, E. 2006, 'Questing for coherence: an analysis of empirical findings in networked learning research in higher education'. *Educational Research Review*, vol.1, no. 2, pp. 99-111.

de Laet, M., & Mol, A. 2000, 'The Zimbabwe Bush Pump: Mechanics of a Fluid Technology', *Social Studies of Science*, vol. 30, no. 2, pp. 225-263.

De Landa, M. 1994, *War in the Age of Intelligent Machines*, Zone Books, New York.

De Vaney, A., & Butler, R. P. 1996, 'Voices of the Founders: Early Discourses in Educational Technology', in D. H. Jonassen [ed.], *Handbook of Research for Educational Communications and Technology*, Simon Schuster Macmillan, New York, pp. 3-45).

Dearing, R. 1997, *Dearing Report, Higher Education in the Learning Society*, Government Stationery Office, London.

Denenberg, Steward, A. 1978, 'A Personal Evaluation of the PLATO System', *Position Paper ACM SIGCUE Bulletin,* vol. 12, no. 2, pp. 3-10.

Derrida, J. 1996, *Archive Fever. A Freudian Impression*. University of Chicago Press, Chicago.

DfEE[46] 1998, T*he Learning Age*, Government Stationery Office, London.

DfES 2003, *Towards a Unified e-Learning Strategy*, Government Stationery Office, London.

DfES 2005, 'Harnessing technology Transforming Learning and Children's Services,' *Department for Education and Skills*, Government Stationery Office, London.

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[46] Department of Education England, Former names (DES, DFE, DfEE, DfES, DCSF) are retained in reference to printed materials.

Digital Education Resource Archive (DERA), UCL Insitutue of Education, viewed 29 November 2015, <http://dera.ioe.ac.uk/information.html>.

Dillenbourg, P., Huang, J., & Cherubini, M. 2008, Interactive Artifacts and Furniture Supporting Collaborative Work and Learning, Springer, New York.

Dirckinck-Holmfeld, L., Jones, C., & Lindstrom, B. 2009, Analysing Networked Learning Practices in Higher Education and Continuing Professional Development Technology Enhanced Learning, Sense Publishers, Rotterdam.

Driscoll, M. 2002, 'Blended learning: Let's get beyond the hype', *E-Learning*, no.3, no.3, pp. 3-54.

Dueber, B. 2004, An Exploration of the Literature of Instructional Technology through Citation Analysis. Dissertation research, Indiana State University US, viewed 9 November 2015, <http://billdueber.com/dissertation/dueber_prospectus.pdf>

Dyke, M., Conole, G., Ravenscroft, A., & de Freitas, S. 2007, 'Learning theory and its applications to e-learning', in G. Conole [ed.], *Contemporary Perspectives in E-learning Research: Themes, Methods And Impact*, Taylor & Francis, Abindon, Oxon, pp. 82-97.

Education Evaluation QUADS Project 2005, viewed 28 November 2015 < http://quads.esds.ac.uk/>

Education Reform Act 2002, 107th U.S. Congress, H.R. 3801.

Edwards, A. D. N., & Hollard, S. [eds.], 1992, *Multimedia Interface Design in Education*, Springer-Verlag, Berlin.

Edwards, R. & Carmichael, P. 2012, 'Secret codes: the hidden curriculum of semantic web technologies', *Discourse: Studies in the Cultural Politics of Education*, vol. 33, no. 4, pp. 575–90.

Edwards, R. & Fenwick, T. 2015, 'Digital analytics in professional work and learning', *Studies in Continuing Education*, no. August, pp. 1–15.

Edwards, R. 2012, 'Translating the Prescribed into the Enacted Curriculum in College and School', in T. Fenwick & R. Edwards [eds.], *Researching Education Through Actor-Network Theory*, Wiley-Blackwell, London pp. 23-39.

Edwards, R. 2015, 'Software and the hidden curriculum in digital education', *Pedagogy, Culture & Society*, vol. 23, no. 2, pp. 265–79.

Edwards, R., Nicoll, K., Solomon, N., & Usher, R. 2004, *Rhetoric and Educational Discourse Persuasive Texts?* Routledge Falmer, London.

Effective Practice in a Digital Age 2010, *Joint Information Systems Committee UK e-Learning Programme Publication*, JISC innovation group, Bristol.

Elliott, C. 2015, *Physics in 1960s: PLATO*, Illinois: University of Illinois, viewed 9 November 2015, <https://physics.illinois.edu/history/PLATO.asp>

Ely, D. 2000, *Trends in educational technology*, ERIC Database, viewed 9th November 2015, < http://eric.[ed.]gov/?id=ED346850>

Engelbart, D. 1962, *Augmenting Human Intellect: A Conceptual Framework*, SRI Summary Report AFOSR-3223, prepared for the Director of Information Sciences, Air Force Office of Scientific Research, Washington DC.

Engeström, Y. 1987, *Learning by Expanding: An Activity-theoretical Approach to Developmental Research*, Orienta-Konsultit, Oy.

European Commission 2001, *New Research Challenges for Technology Supported Learning*, viewed 9 November 2015, <http://cordis.europa.eu/ist/telearn/consultation.htm>

Evans, C. R. 1979, The Mighty Micro: Impact of the Computer Revolution, Gollancz, UK.

Fairclough, N. 2003, *Analysing Discourse: Textual Analysis for Social Research*, Routledge, London.

Fardanesh, H. 2006, *A Classification of Constructivist Instructional Design Models Based on Learning and Teaching Approches*, ERIC Database, viewed 9th November 2015, < http://files.eric.[ed.]gov/fulltext/ED491713.pdf>

Fejes, A., & Nicoll, K. 2008, *Foucault and lifelong learning: governing the subject,* Routhledge Tayor & Francis Group, London & New York.

Fenwick, T., & Edwards, R. 2010, *Actor network theory in education,* Routledge, New York & London.

Fenwick, T., & Edwards, R. 2012, 'Introduction', in T. Fenwick & R. Edwards [eds.], *Researching Education Through Actor-Network Theory,* Wiley-Blackwell, London, pp. ix-xxiii.

Fenwick, T., Edwards, R., & Sawchuk, P. 2011, *Emerging Approaches to Educational Research: Tracing the Socio-Material*, Routledge, Abingdon, Oxon.

Feuer, M. J., Feuer, M. J., Towne, L., Towne, L., Shavelson, R. J., & Shavelson, R. J. 2002, 'Scientic Culture and Educational Research', *Educational Researcher*, vol. 31, no. 8, pp. 4-14.

Field, J., Gallacher, J., & Ingram, R. 2009, *Researching Transitions in Lifelong Learning* Taylor & Francis, Abindon, Oxon.

Fleck, J. 1982 , 'Development and establishment in artificial intelligence', in *Scientific establishments and hierarchies. Sociology of Sciences Yearbook Vol 6*, Reidel, Dordrecht, pp. 169-217.

Foucault, M. 2001b, *The Order of Things* 2nd edn, Rothedge Tayor & Francis Group, London & New York.

Foucault, M. 2003, *The Birth of the Clinic*, 3rd edn, Routledge Taylor & Francis Group, London & New York.

Foucault, M. 1981, 'The Order of Discourse,' in R. Young (ed.), *UnTying the Text: a Post-Structuralist Reader*, Routledge & Kegan Paul Ltd., Boston MA, pp. 48–78.

Foucault, M. 1990, 'Michel Foucault, Politics, Philosophy, Culture: Interviews and Other Writings 1977-1984', in L. D. Kritzman [ed.], Routledge, New York & London.

Foucault, M. 1991, 'Questions of method', in G. Burchell, C. Gordon, & P. Miller [eds.], *The Foucault Effect Studies in Governmentality*, The University of Chicago Press, Chicago, pp.73-86.

Foucault, M. 1995, *Discipline and Punish: The Birth of the Prison*, trans. A. Sheridan, Vintage Books, New York.

Foucault, M. 2001a, *Madness and Civilization: A History of Insanity in the Age of Reason* 2nd edn, Rothedge Tayor & Francis Group, London & New York.

Foucault, M. 2002, *Archaeology of Knowledge*. Routledge Classics, London & New York.

Foucault, M., Burchell, G., Gordon, C., & Miller, P. 1991, *The Foucault Effect: Studies in Governmentality*, University of Chicago Press Chicago.

Fowler, C. J. H., & Mayes, J. T. 1999, 'Learning relationships from theory to design', *Association for Learning Technology Journal*, vol. 7, no. 3, pp. 6-16.

Fowler, C. J. H., & Mayes, J. T. 2000, 'Learning relationships from theory to design', in D. Squires, G. Conole, & G. Jacobs [eds.], *The Changing Face of Learning Technology*, University of Wales Press, Cardiff.

Fox, S. 2000, 'Communities of Practice, Foucault and Actor-Network Theory', *Journal of Management Studies*, vol. 37, no. 6, pp. 853-867.

Fox, S. 2005, 'An actor-network critique of community in higher education: implications for netowrked learing', *Studies in Higher Education,* vol. 30, no. 1, pp.95-110.

Galagan, P.A. 2000, 'Mission E-Possible: The Cisco E-Learning Story.' *Training & Development*, vol. 55, no. 2, pp. 46–56.

Gardner, C., & Young, M. 1981, 'Science on TV a Critique', in *Popular Television and Film: a Reader,* in T. Bennett, S. B. Bowman, C. Mercer, J. Wollacott [eds.], BFI/Open University Press, London.

Garrison, D.R. 1987, 'Self-direction and distance learning: Facilitating self-directed learning beyond the institutional setting.' *International Journal of Lifelong Education*, vol. 6, no. 4, pp. 306–18.

Geiger, T., Moore, N., & Savage, M. 2010, *The Archive in Question*, CRESC Working Paper Series, Working Paper no 81, viewed 9th November 2015 <http://www.cresc.ac.uk/medialibrary/workingpapers/wp81.pdf>

Gerrie, J. 2003, 'Was Foucault a Philosopher of Technology?' *Techné: Research in Philosophy and Technology*, vol. 7, no. 2 , viewed 9 November 2015, <http://scholar.lib.vt.edu/ejournals/SPT/v7n2/gerrie.html>

Gibbons, M. 1994, The new production of knowledge: the dynamics of science and research in contemporary societies, Sage New York & London.

Gillard, D. 2009, *Short and Fraught: the history of primary education in England.* viewed 9 November 2015, < http://www.educationengland.org.uk/articles/28primary.html>

Gillard, D. 2011, *Education in England: a brief history*, viewed 9 November 2015, < http://www.educationengland.org.uk/history/chapter08.html >

Glymour, C. 1997, *Thinking Things Through: Introduction to Philosophical Issues and Achievements*, MIT Press, Cambridge, Massachusetts.

Glynos, J., & Howarth, D. 2007, *Logics of Critical Explanation in Social and Political Theory*, Routledge, London.

Goldstein, H. 1998, *How can we evaluate Educational research?* Institute of Education, London, viewed 9 November 2015, <http://www.bristol.ac.uk/media-library/sites/cmm/migrated/documents/tooley-darby-critique.pdf>

Goodyear, P. M., Banks, S., Hodgson, V. & McConnell, D. 2004, Research on networked learning : an overview', in P. M. Goodyear, S. Banks, V. Hodgson, & D. McConnell [eds.], *Advances in Research on Networked Learning*, Kluwer Academic, Dordrecht, pp. 1-10.

Gorard, S., & Taylor, C. 2004, *Combining Methods In Educational And Social Research*, McGraw-Hill International, London.

Gorur, R. 2012, 'ANT on PISA Trail: Following the statistical Pursuit of certainty', in T. Fenwick & R. Edwards [eds.], *Researching Education Through Actor-Network Theory* Wiley-Blackwell, London, pp. 60-77

Gough, N. 2004, 'RhizomANTically Becoming-Cyborg: Performing posthuman pedagogies,' *Educational Philosophy and Theory*, vol. 36, no. 3, pp. 253–65.

Graham, L. J. 2005, 'Discourse Analysis and the Critical Use of Foucault*', The Australian Association of Research in Education Annual Conference*, Parramatta, Sydney, viewed 10 November 2015 < http://eprints.qut.edu.au/2689/>

Gray, A., & Bell, E. 2013, *History on Television Vol. 4*, Routledge, London.

Guide to using the community memory circa 1972, Community Memory Flyer Berkeley California, viewed 29 November 2015< http://www.well.com/~szpak/cm/index.html>

Guthrie, K. 2001, 'Archiving in the digital age: there's a will, but is there a way?,' *Educause*, November/December, pp. 57–65.

Hamilton, M. 2012, 'Unruly Practices: What a sociology of translations can offer to educational policy analysis', in T. Fenwick & R. Edwards [eds.], *Researching Education Through Actor-Network Theory* Wiley-Blackwell, London, pp. 40-59.

Hamilton, M., & Merrifield, J. 1999, 'Adult Learning and Literacy in the United Kingdom', *Review of Adult Learning and Literacy. Volume 1. Chapter Seven,* NCSLL, viewed 10 November 2015, <http://www.ncsall.net/index.html@id=520.html>

Hammond, N. 2003, 'ALT: How did it all start?' *Issue No 42 Association for Learning Technology Newletter*, July, p2.

Haque, U. 2007, The Architectural Relevance of Gordon Pask', *Architectural Design*, vol. 77 no. 4. pp. 54-61.

Haraway, D. J. 1991, 'A Cyborg Manifesto: Science, Technology, and Socialist-Feminism in the Late Twentieth Century', in *Simians, Cyborgs and Women: The Reinvention of Nature* Routledge, New York, pp. 149-181.

Hargreaves, A. 1996, 'Transforming Knowledge: Blurring the Boundaries between Research, Policy, and Practice', *Educational Evaluation and Policy Analysis*, vol. 18, no. 2, pp.105 -122.

Harwood, V. 2001, 'Foucault, narrative and the subjugated subject: Doing research with a grid of sensibility', *The Australian Educational Researcher*, vol. 28, no. 3, pp. 41-166.

Hattie, J. 2009, Visible Learning: A Synthesis of Over 800 Meta-Analyses Relating to Achievement, Routledge, Abingdon, Oxon.

Hawksey 2012, *JISC CETIS*, viewed <https://mashe.hawksey.info/category/jisc/jisc-cetis/>

Haxell, A. 2008, 'Cn I jus txt , coz I don wan 2b heard : Mobile technologies and youth counselling', *Hello! Where are you in the landscape of educational technology? Proceedings ascilite Melbourne 2008*, pp. 405–8.

Hayes, S. 2015, MOOCs and Quality: A Review of the Recent Literature, QAA MOOCs Network, London.

Hayles, K. 1999, 2008, *How We Became Posthuman: Virtual Bodies in Cybernetics, Literature, and Informatics*, electronic book, University of Chicago Press.

HECTIC. 2002, *European Union Policies and Strategic Change for e-Learning: Report of the project 'Higher Education Consultation in Technologies of Information and Communication (HECTIC)'*, Combra Group of Universities, April 2002 Brussels.

Hedberg, J. G., & McNamara, S. 2002, 'Innovation and Re-Invention: A Brief Review Of Educational Technology In Australia', *Educational Media International*, vol. 39. no. 2, pp. 111-121.

Hergenhahn, B. 2008, *An Introduction to the History of Psychology*, 5th edn, Wadsworth Cengage Learning, Belmont, CA.

Hernandez, D. 2012, 'Facebook?! Twitter?! Instagram?! We Did That 40 Years Ago', *Wired Magazine Business,* 24 December, p.3.

Higgins, S., Xiao, Z. & Katsipataki, M. 2012, 'The Impact of Digital Technology on Learning : A Summary for the Education Endowment Foundation Full Report,' *Education Endowment Foundation Durham & University,* pp. 1–52.

Higgins, S., Xiao, Z., & Katsipataki, M. 2012, The Impact of Digital Technology on Learning : A Summary for the Education Endowment Foundation Full Report, Durham University, Durham.

Hlynka, D. 1992, *Post Modern Educational Technology*. Office of Educational Research and Improvement, ERIC Clearinghouse on Information Sources, New York.

Hlynka, D. 2004, 'Postmodernism in Educational Technology: Update 1996 - Present', in D. H. Jonassen [ed.], *Handbook of research for educatinal communications and technology*, 2nd edn, pp. 243-246, Lawrence Erbaum Associates, Mahwah, NJ.

Hoare, T., & Milner, R. [eds.]2004, *Grand Challenges in Computing Research*, British Computer Society & EPSRC (& sponsors), London.

Hoppe, H. U., Ogata, H., & Soller, A. [eds.]2007, *The Role of Technology in CSCL. Studies in Technology Enhanced Collaborative Learning*, Springer, Boston, MA.

Hunter, S.D.J. & Swan, S.E. 2007, 'Oscillating politics and shifting agencies: equalities and diversity work and actor network theory,' *Equal Opportunities International*, vol. 26, no. 5, pp. 402–19.

Hutchins, E. 1995, *Cognition in the Wild*. MIT Press, Cambridge, Massachusetts.

Isaacson, W. 2013, *Steve Jobs: The Exclusive Biography*, Little Brown, London.

Jalote, P. 2008, *A Concise Introduction to Software Engineering Undergraduate Topics in Computer Science*, Springer Verlag, London.

James, M. & Pollard, A. 2011, 'TLRP's ten principles for effective pedagogy: rationale, development, evidence, argument and impact,' *TLRP Programme Publication*, IoE, London.

James, M., & Brown, S. 2005, 'Grasping the TLRP nettle: preliminary analysis and some enduring issues surrounding the improvement of learning outcomes', *The Curriculum Journal*, vol.16, no. 1, pp. 7-30.

Januszewski, A. 2001, *Educational technology: the development of a concept*. Libraries Unlimited, Englewood Us.

JISC Strategy 2007-2009, 2006, Joint Information Systems Committee UK e-Learning Programme Publication, JISC innovation group, Bristol.

Johnston, S., Lee, A. & Mcgregor, H. 1996, 'Engineering as Captive Discourse', *Society for Philosophy and Technology*, vol 1, no. 3-4, e-jounal.

Jones, C. 2004, 'The metaphor of networks in learning: communities, collaboration and practice' *ALT-J Reseach in Learning Technology*, vol.12, no.1, pp.81-93.

Jones, C., & Czerniewicz, L. 2011, 'Theory in learning technology', *Research in Learning Technology*, vol.19, no.3, pp. 173-177.

Jones, C., Ramanau, R., Cross, S., & Healing, G. 2010, 'Net generation or Digital Natives: Is there a distinct new generation entering university?' *Computers & Education*, vol.54, no.3, pp.722-732.

Jones, K. 2003, *Education in Britain: 1944 to the present* Polity Press, Cambridge, UK.

Kaptelinin, V. & Nardi, B.A. 2006, *Acting with Technology: Activity Theory and Interaction Design*, The MIT Press, Cambridge, Massachusetts.

Kay, A. C. 1972, A Personal computer for children of all ages, in *Proceedings of the ACM National Conference, Boston*, August 1972.

Kelly, M. 2010, 'Michel Foucault (1926-1984)', *Internet Encyclopedia of Philosophy*, viewed 10 November 2015, <http://www.iep.utm.edu/foucault/#SH4b>

Kendall, G., & Wickham, G. 999, *Using Foucault's methods*, Sage Publications, Michigan US.

Kennedy, H. 1997, *Kennedy Report Learning Works: Widening Particiaption in Further Education*, Government Stationery Office, London.

Kirby, J. A., Hoadley, C. M., & Carr-Chellman, A. A. 2005, 'Instructional systems design and the learning sciences: A citation analysis', *Educational Technology Research and Development*, vol. 53, no.1, pp. 37-47.

Kirkwood, A. & Price, L. 2013, 'Technology-Enhanced Learning and Teaching in Higher Education: What is 'Enhanced' and How Do We Know? A Critical Literature Review', *Learning, Media and Technology*, vol. 39, no. 1, pp. 6–36.

Klein, J. T. 2008, 'Evaluation of interdisciplinary and transdisciplinary research: a literature review', *American Journal of Preventive Medicine*, vol.35, no. 2, pp. 116-23.

Knox, J. 2013, 'Five critiques of the open educational resources movement', *Teaching in Higher Education*, vol. 18, no. 1, pp. 821–32.

Knox, J. 2014, 'Digital culture clash: "Massive" education in the e-learning and digital cultures MOOC', *Distance Education*, vol. 35, no. 2, pp. 164–77.

Koschmann, T. D. 1996, *CSCL, theory and practice of an emerging paradigm*, Routledge, London.

Kuhn, T. S., & Hacking, I. 2012, *The Structure of Scientific Revolutions: 50th Anniversary Edition*, University of Chicago Press, Chicago.

La Mettrie, J. O. 1994, *Man a Machine and Man a Plant*, Hackett Publishing Company, US.

Lally, V. 2013, *Inter-Life Interoperability and Trasition ESRC End of Award Report*, RES-139-25-0402, ESRC, Swindon.

Lally, V., Sharples, M., Bertram, N., Masters, S., Norton, B., & Tracy, F. 2011, 'Mobile, Ubiquitous and Immersive Tehcnology enhanced Learning: an ethical perspective', *A Research Breifing published by the TLRP-TEL Programme*, LKL IoE, London.

Lannom, L. 2012, 'Web Archiving Editorial', *D-Lib Magazine. The Magazine of Digital Library Research*, vol.18, no. 3-4, viewed 9 November 2015, <http://www.dlib.org/dlib/march12/03editorial.html>

Latour, B. 1987, *Science in Action: How to Follow Scientists and Engineers Through Society,* Harvard University Press, Cambridge, Massachusetts.

Latour, B. 1988, 'How to write "The Prince" for machines as well as for machinations', in B. Elliott [ed.], *Technology and Social Change,* Edinburgh University Press, Edinburgh, pp. 20-43.

Latour, B. 1993, *We have never been modern*, Harvard University Press, Cambridge, Massachusetts.

Latour, B. 1996, *Aramis or The love of technology*, Harvard University Press, Cambridge, Massachusetts.

Latour, B. 2004, *Politics of Nature: How to Bring the Sciences into Democracy*. Harvard University Press, Cambridge, Massachusetts.

Latour, B. 2005, *Reassembling the Social: An Introduction to Actor-Network-Theory*, Oxford University Press, Oxford.

Latour, B. 2014, A New Method to trace the path of innovations. The "socio-technical graph". 44bis Socio-technical graph (unpublished in English), viewed 9 November 2015, <http://www.bruno-latour.fr/> .

Latour, B., & Woolgar, S. 1986, *Laboratory life: the construction of scientific facts*. Princeton University Press, Princeton New Jersey.

Laurillard, D. 2002, Rethinking University Teaching: A Conversational Framework for the Effective Use of Learning Technologies, 2nd edn, RoutledgeFarmer, London.

Laurillard, D. 2007, 'Technology in the service of our educational ambitions: Bringing it into the mainstream,' *The 12th Cambridge International Conference on Open and Distance Learning*, pp. 25–8 September 2007.

Laurillard, D. 2008, 'Digital technologies and their role in achieving our educational ambitions', *Professorial lecture Institute of Education, University of London*, Powerpoint presentation 26 February 2008.

Laurillard, D. 2012, *Teaching as a Design Science Building Pedagogical Patterns for Learning and Technology*, Routhledge Tayor & Francis Group, London

Law, D. 2006, 'Remembering history: The work of the Information Services Sub-Committee of the Joint Information Systems Committee in the UK', *Program: Electronic Library and Information Systems*, vol.40, no. 4, pp.315-324.

Law, J. 2000, 'On the Subject of the Object: Narrative, Technology, and Interpellation', *Configurations*, vol.8, no. 1, pp.1-29.

Law, J. 2002, 'On Hidden Heteregeities: Complexity, Formalism, and Aircraft Design', in *Complexities: social studies of knowledge practices*, J. Law & A. Mol [eds.], Dukes University Press, Durham NC, pp.116-141.

Law, J. 2004, *After Method mess in social science research*, Duke University Press, Durham NC.

Law, J. 2007, 'Making a mess with method,' in W. Outhwaite & S.P. Turner (eds), *Sage Handbook of Social Science Methodology*, Sage, London and Beverly Hills, pp. 595–606.

Law, J., Afdal, G., Asdal, K., Lin, W., Moser, I., & Singleton, V. 2013, 'Modes of Syncretism : notes on non-coherence', *CRESC Working Paper Series, Working Paper No. 119*, viewed 9 November <http://www.cresc.ac.uk/medialibrary/workingpapers/>

Law, J., Ruppert, E., & Savage, M. 2011, The Double Social Life of Methods, *CRESC Working Paper Series, Working Paper No. 95*, viewed 9 November <http://www.cresc.ac.uk/medialibrary/workingpapers/>

Leonard, K., Noh, E. K., & Orey, M. 2007, 'Introduction to Emerging Perspectives on Learning, Teaching, and Technology', in M. Orey [ed.], *Emerging perspectives on learning, teaching, and technology*, AECT, Washington US

Leonard, K., Noh, E.K. & Orey, M. 2007, 'Introduction to Emerging Perspectives on Learning, Teaching, and Technology.,' in M. Orey (ed.), *Emerging perspectives on learning, teaching, and technology*, AECT, Washington US.

Levy, S. 1994, Insanely Great: The Life and Times of Macintosh, the Computer That Changed Everything, Reissue edition, Penguin, London.

Lipkin, E., Szpakowski, M., & Felsenstein, L. 1974, 'At last... A Community Memory!' *Resource One Newsletter*, 2nd April.

Loving grace cybernetics circa 1972, Community Memory Flyer Berkeley California, viewed 29 November 2015 < http://www.well.com/~szpak/cm/cmflyer.html >

Luckin, R. & Underwood, J. 2011, *Themes and trends in AIED research, 2000 to 2010. , A Research Breifing published by the TLRP-TEL Programme*, LKL IoE, London.

Luppicini, R. 2005, A systems definition of educational technology, *Educational Technology and Society*, vol. 8, no. 3, pp.103-109.

Lyotard, J. F. 1988, *The Postmodern Condition: A Report on Knowledge (Theory & History of Literature),* trans. G. Bennington, B. Massumi, B, University of Minnesota Press, Minneapolis.

Lyotard, J. F.1988 , 'Can Thought Go On Without A Body?', tran. B. Boone, & L. Hildreth,   *Discourse*, vol.11, no. 1, pp. 74-87.

Macdonald, K. 1996, *Sociology of the Professions*, Sage Publications, London.

Macromedia 2003, 'Macromedia, Inc. History', *International Directory of Company Histories*, *50*., viewed 9 November 2015, <http://www.fundinguniverse.com/company-histories/macromedia-inc-history/>

Manoff, M. 2004, 'Theories of the Archive from Across the Disciplines' *Portal: Libraries and the Academy Project Muse*, vol. 4, no. 1, p. 9-25.

Mark 1 the baby 1948, You Tube video The "Baby" computer, reported by the BBC (uk) in 1948, *Computers in 1948*, viewed 29 November 2012, <https://www.youtube.com/watch?v=SNwvJ7psoow>

Markoff, 1. 2005, *What the Dormouse Said: How the Sixties Counterculture Shaped the Personal Computer Industry*, Reprint edition, Penguin, London.

Martínez-Garcia, A., Morris, S., Tscholl, M., Tracy, F., & Carmichael, P. 2012, 'Case-based learning, pedagogical innovation, and semantic web technologies', *IEEE Transactions on Learning Technologies*, vol. 5, no. 2, 104-116.

Marx, R. W., & Harris, C. J. 2006, 'No Child Left Behind and Science Education: Opportunities, Challenges, and Risks', *The Elementary School Journal*, vol.106, no. 5, pp. 467 - 477.

Mayes, T., & de Freitas, S. 2005, 'Stage 2: Review of e-learning theories, frameworks and models', *JISC e-Learning Models Desk Study.* downloaded 1st August 2010 Viewed 9 November 2015

Mayes, T., Bullen, P., Oliver, M., Mellar, H., & Morrison, D. 2009, *Transforming Higher Education through Technology Enhanced Learning*. Higher Education Academy, York.

McCarthy, J., Minsky, M. L., Rochester, N., & Shannon, C. E. 1955, *A proposal for the Dartmouth Summer Research Project on Artifical Intelligence*, viewed 1 November 2015 < file:///C:/Users/Uma/Desktop/Downloads/1904-1900-1-PB.pdf>

McCorduck, P. 1979, *Machines Who Think: A Personal Inquiry into the History and Prospects of Artificial Intelligence*, W. H. Freeman, San Francisco.

McGettrick, A., Boyle, R., Ibbett, R., Lloyd, J., Lovegrove, G., & Mander, K. 2005, 'Grand Challenges of Computing in Education', *Computing Journal*, vol. 48, no. 1, pp. 42-48.

McHoul, A. & Grace, W. 2015, *A Foucault Primer: Discourse, Power And The Subject*, Routledge, London.

McLean, C., & Hassard, J. 2004, Symmetrical Absence/Symmetrical Absurdity: critical notes on the production of actor-network, *Journal of Management Studies*, vol.41, no. 3, pp. 493-519.

Meakin, D., Bibby, M., Glover, P. [eds.]1985, *Micro user magazine.* 1985 Database Publications Ltd., viewed 9 November 2015, <http://myweb.tiscali.co.uk/themicrouser/TMUIndex/TMU03-02.htm

Merrill, D., Barclay, M., & Schaak, A. V. 2008, 'Prescriptive Principles for Instructional Design', in D. Jonassen, M. J. Spector, M. P. Driscoll, & J. van

Merrienboer [eds], *Handbook of Research on Educational Communications and Technology,* revised 3ʳᵈ edn, Routledge, New York.

Merrill, D., Drake, L., Lucy, M. J., Pratt, J., & ID₂ Research Group Utah State University, 1996, 'Reclaiming Instructional Design', *Educational Technology*, vol. 36, no. 5, pp. 5-7.

Metz, C. 2008, 'The Mother of All Demos - 150 years ahead of its time', *The Register*, viewed 9 November 2015, <http://www.theregister.co.uk/2008/12/11/engelbart_celebration/>

Miettinen, R. 1999, 'The riddle of things: activity theory and actor-network theory approaches to studying innovations,' *Mind, Culture, and Activityulture and Activity*, vol. 6, no. 3, pp. 170–95.

Miller, G. A. 2003, 'The cognitive revolution: a historical perspective', *Trends in Cognitive Sciences*, vol. 7, no. 3, pp.141-144.

Minsky, M. 1961, 'Steps toward Artificial Intelligence', *Proceedings of the IRE*⁴⁷, vol. 49, no. 1, pp. 8-30.

Mol, A. 2002, *The Body Multiple: Ontology in Medical Practice*, Duke University Press Durham, NC.

Morris, S. 2012, *Case Study: Using the Semantic Web to Enhance the Teaching of Dance. W3C*, viewed 9 November 2015, <http://www.w3.org/2001/sw/sweo/public/UseCases/LJMU/>

Mort, D. [ed.] 2003, *Business Information Handbook 2003*, Walter de Gruyter, Munchen.

Moser, I., & Law, J. 1999, 'Good Passages, Bad Passages', in J. Law & J. Hassard [eds], *Actor Network Theory and After*, Blackwell, Oxford UK.

Mulcahy, D. 2007, 'Managing spaces: (re)working relations of strategy and spatiality in vocational education and training,' *Studies in Continuing Education*, vol. 29, no. 2, 143-162

---

⁴⁷ This Periodical ceased production in 1962. The current retitled publication is Proceedings of the IEEE.

Mulcahy, D. 2012, 'Assembling the "Accomplished" Teacher: The performativity and politics of professional teaching standards' in R. Edwards & T. Fenwick [eds.]*Researching Education Through Actor-Network Theory,* London: Wiley-Blackwell, London, pp. 78-96.

Murphy, A. (2005) 'Lifelong learning:romance, evidence, implementation?' *ITAC, Institutes of Technology Apprentice Committee Conference,* Conference papers ARROW@DTI, Dublin.

Murphy, A. 2005, *Lifelong learning:romance, evidence, implementation?* Dublin. , Viewed 9 November 2015, <http://arrow.dit.ie/cgi/viewcontent.cgi?article=1000&context=ltccon

Myers, B. A. 1996, *A Brief Hisotry of Human Computer Interaction Technology*, viewed 9 November 2015, <http://www.cs.cmu.edu/~amulet/papers/uihistory.tr.html>

Naughton, J. 2012, 'The BBC Micro can still teach us a lot', *The Guardian*. March 25

Naur, P., & Randell, B. 1968, 'Software Engineering: Report of a conference sponsored by the NATO Science Committee, Garmisch, Germany', *NATO Software Engineering Conference*, 7-11 Oct. 1968.

Nead, L. 1990, Myths of Sexuality: Representations of Women in Victorian Britain, Wiley-Blackwell, London.

Nead, L. 2000, *Victorian Babylon: People, Streets and Images in Nineteenth-Century London*, Yale University Press, Michigan.

Negroponte, N. 2007, 'The $100 laptop', in *Proceedings of Globalization and Education: Joint Working Group*, the Pontifical Academy of Sciences, the Pontifical Academy of Social Sciences, Walter de Gruyter, 16-17 November.

Nelson, T. H. 1965, 'A File Structure for the Complex , the Changing , and the Indeterminate', *Proceeding ACM '65 Proceedings of the 1965 20th national conference*, Cleveland, Ohio, ACM publication, pp. 84-100.

Nelson, T. H. 1974, *Computer Lib: You Can and Must Understand Computers Now; Dream Machines: New Freedoms Through Computer Screens— A Minority Report*, Self-published Hugo's Book Service for authors[48], Chicago.

Nespor, J. 2012, 'Devices and Educational Change', in T. Fenwick & R. Edwards [eds.]*Researching Education Through Actor-Network Theory*, Wiley-Blackwell, London, pp. 1-22.

Nespor, J. 1994, *Knowledge in motion: space, time, and curriculum in undergraduate physics and management*, vol. 1994, Falmer Press, London.

Nicoll, K. 2008, 'Discipline and e-learning', in A. Fejes & K. Nicoll [eds.], *Foucault and Lifelong Learning. Governing the Subject*, Routhledge Tayor & Francis Group, London, pp. 164-177.

Nicoll, K. 2006, *Flexibility and Lifelong Learning*, Routhledge, London.

Nimmo, R. 2011, 'Actor-network theory and methodology : social research in a more-than-human world', *Methodological Innovations Online*, vol. 6, no. 3, pp. 108-119.

NISO Framework Working Group 2007, *A Framework of Guidance for Buidling Good Digital Collections*, National Information Standards Organization (NISO), Baltimore.

Norvig, P. 2011, *On Chomsky and the two Cultures of Statistical Learning*, viewed 26 November 2015 < http://norvig.com/chomsky.html>

Noss, R. 2007, *TLRP-TEL Feedback Workshop: Nov 9 2007*. Viewed 9 November 2015, <http://www.tlrp.org/tel2/documents/RNTEL091107.pdf>

Noss, R. 2012, 'Learning the Unlearnable: Teaching the Unteachable', *Melbourne Graduate School: Deans's Lecture Series*, You Tube video, viewed 9 November 2015, <https://www.youtube.com/watch?v=RdQF7unS3gg&feature=youtu.be>

Noss, R., Cox, R., Laurillard, D., Luckin, R., Plowman, L., Scanlon, E. & Sharples, M. 2012, *System Upgrade: Realising the Vision for UK Education.*, viewed 9

---

[48] Two books were jointed in a tête-bêche format. A reprint edition was created from negative in 2013 by the author

November 2015 < http://tel.ioe.ac.uk/wp-content/uploads/2012/06/TELreport.pdf>

Noss, R., Scanlon, E., Sharples, M., Fenton-O'Creevy, M., Fleck, J., Cooban, C., Ferguson, R., Cross, S. & Waterhouse, P. 2013, *Beyond prototypes Enabling innovation in technology-enhanced learning*, London, viewed 9 November 2015 < http://beyondprototypes.com/>

Nowotny, H., Scott, P., & Gibbons, M. 2001, *Re-thinking science: knowledge and the public in an age of uncertainty*. Wiley-Blackwell, London.

Nuyens, Y. 2005, 'No development without research: A challenge for capacity strengthening', *Global Forum for Health Research*, Geneva.

Nyce, J., & Kahn, P. [eds.] 1991, *From Memex to Hypertext: Vannevar Bush and the Mind's Machine*, Academic Press, London.

Okoli, C., & Schabram, K. 2009, 'Working Papers on Information Systems Protocol for a Systematic Literature Review of Research on the Wikipedia', *Sprouts: Working Papers on Information Systems*, Keele: archive.is. , viewed 9 November 2015, <http://sprouts.aisnet.org/9-65>

Oliver, M., & Trigwell, K. 2005, 'Can "Blended Learning" Be Redeemed?', *E-Learning*, vol. 2, no. 1, pp. 17-26.

Oliver, M., Sharpe, R., Duggleby, J., Jennings, D., & Kay, D. 2004, 'Accrediting learning technologists: a review of the literature, schemes and programmes', *ALT accreditation project report no. 1.*, Viewed 9 November 2015, <http://www.ucl.ac.uk/calt/alt-accreditation/Initial_review.doc>

Olsson, U., & Petersson, K. 2008,The operation of knowledge and construciton of the lifelong learning subject' in A. Fejes & K. Nicoll [eds.], *Foucault and Lifelong Learning. Governing the subject*, Routhledge Tayor & Francis Group, London, pp. 61-7.

Orlando, J. 2014, 'Teachers' changing practices with information and communication technologies: an up-close, longitudinal analysis,' *Research in Learning Technology*, vol. 22, no. 1, pp 1-15.

Owen, L. 1991, 'Vannevar Bush and the differential analyzer: the text and context of an early computer', in J. M. Nyce & P. Kahn [eds.], *From Memex to hypertext: Vannevar Bush and the Mind's Machine*, Academic Press Professional, Inc., San Diego, CA, pp. 3-38.

Papert, S. 2000, 'What's the big idea? Toward a pedagogy of idea power', *IBM Systems Journal*, vol. 39, no.3/4, pp. 720-729.

Papert, S. 1993, *Mindstorms: children, computers, and powerful ideas* revised, 2nd edn, Basic Books, New York.

Papert, S., & Harel, I. [eds.]1991, *Constructionism: research reports and essays 1985 – 1990*, Epistemology and Learning Research Group, the Media Lab, Massachusetts Institute of Technology, Ablex Pub. Corp, Norwood, New Jerseu.

Papert, S., & Silverman, B. 1997, *MicroWorlds 2.0 User Guide*, in G. Dresher, [ed.], Logo Computer systems Inc.

Pask, G. 1976, Conversational techniques in the study and practice of education. *British Journal of Educational Psychology*, vol. 46, no. -, pp.12-25.

Pask, G. 1980, 'The Limits of Togetherness, Invited Paper', in S. H. Lavington [ed.], *Information Processing,* vol. 80, no. -, pp. 999-112,. North-Holland Publishing Company.

Pastor, R. R., & Quiros, T. C. 2015, *Learning and teaching technology options STOA - Science and Technology Options Assessment*, EPRS European Parliamentary Research Service, Scientific Foresight Unit (STOA), Brussels.

Patel, U., & Sutcliffe, A. 1993, Three-dimensional visualisation of knowledge structures: Prototyping for design evaluation, in *Human-Computer Interaction* pp. 163-180, Springer, Berlin Heidelberg.

Patel, U., Solomon, N. and Solkin, L. (2007) 'Moving where? Problematising Knowledge Cumulation in Technology Enhanced Learning', *4th International Conference on Researching Transitions in Lifelong Learning.* University of Sterling, Scotland 22-24 June. Glasgow Caledonian University & University of Sterling: Centre for Research in Lifelong Learning. [CD:ROM]: Item 08

Perelman, L.C. 1999, 'The Two Rhetorics : Design and Interpretation in Engineering and Humanistic Discourse,' *Language and Learning Across the Disciplines*, vol. 3, no. 2, pp. 64–82.

Perrotta, C. 2012, 'Assessment, technology and democratic education in the age of data,' *Learning, Media and Technology*, December 2012, pp. 1–7,

Peters, M. A. 2004, 'Educational research : " games of truth " and the ethics of subjectivity', *Journal of Educational Enquiry,* vol. 5, no. 2, pp. 50-63.

Peters, M. A., & Biesta, G. 2009, *Derrida, Deconstruction, and the Politics of Pedagogy*, Peter Lang, New York.

Peters, M.A. & Roberts, P. 2012, *The Virtues of Openess*, Paradigm Publishers, London.

Phillips, N., & Hardy, C. 2002, *Discourse analysis: investigating processes of social construction*, Sage Publications, Thousand Oaks CA.

Plotnick, E. 1997, *Concept mapping: a graphical system for understanding the relationship between concepts: an ERIC digest*, ERIC Clearinghouse on Information and Technology, Syracuse NY.

Plowden, B. 1967, *The Plowden Report. Central Advisory Council for Education 1967 , Children and their Primary Schools*, Government Stationery Office London.

Polanyi, M. 1964, *The Study of Man*, University of Chicago Press,Chicago.

Pollard, A. & TLRP 2007, *Principles into practice. A teacher's guide to reserach evidence on teaching and learning, Research into action*, TLRP Programme Publication, IoE, London.

Pollard, A. 2002, 'TLRP : academic challenges for moral purposes', *TLRP annual Conference*, Cambridge September 2002.

Pollard, A. 2005, Challenges facing educational research, *Educational Review Guest Lecture,* vol. -, no.1, pp. 251-267.

Pollard, A., & James, M. 2007, 'What have we learned about pedagogy from TLRP, and what do we need in the future?' *DCSF, National Strategy and TLRP Workshop*, 16th October 2007, Insitutue of Education, London, pp. 7-30.

Pollard, C., & Pollard, R. 2005, Research priorities in educational technology: a Delphi study. *Journal of Research on Technology in Education*, vol. 37, no. 2, pp.145-160.

Popkewitz, T. S. 2008, 'The reason of reason: cosmopolitanism, social exclusion and lifelong learning' in A. Fejes & K. Nicoll [eds.], *Foucault and Lifelong Learning. Governing the subject*, Routhledge Tayor & Francis Group, London, pp. 74-86.

Potter, J. & Hepburn, A. 2007, 'Discursive constructionism,' in J.A. Holstein & J.F. Gubrium (eds.), *Handbook of constructionist research*, the Guildford Press, New York, pp. 275–393.

Potter, J., & Hepburn, A. 2007, Discursive constructionism, in J. A. Holstein & J. F. Gubrium [eds.], *Handbook of constructionist research*, the Guildford Press, New York, pp. 275-393.

Pugh, E. W. 2009, Building IBM: Shaping an Industry and Its Technology History of Computing, MIT Press, Cambridge, Massachusetts.

Rabinow, P., & Rose, N. 2003, 'Foucault Today' in P. Rabinow & N. Rose [eds.], *the Essential Foucault: selections from the essential works of Foucault, 1954-1984*, New Press, New York, pp. vii-xxxv.

Radcliffe, J., & Salkeld, R. [eds.] 1983, *Towards Computer Literacy The BBC Computer Literacy Project 1979 – 1983*, BBC Insight Continuing Education, London.

Rees, G., Baron, S., Boyask, R., & Taylor, C. 2007, 'Research-capacity building, professional learning and the social practices of educational research' *British Educational Research Journal,* vol. 33, no. 5, pp. 761-779.

Reigeluth, C. M., & Carr-Chellman, A. A. 2009, *Instructional-Design Theories and Models, Volume III: Building a common knowledge base*, in C. M. Reigeluth & A. A. Carr-Chellman, [eds.], Routledge, New York.

Reiser, R. A. 2001, 'A history of instructional design and technology: Part I: A history of instructional media', *Educational Technology Research and Development*, vol. 49, no. 1, pp. 53-64.

Reiser, R., & Dempsey, J. V. 2006, *Trends and Issues in Instructional Design and Technology*, Pearson, Boston MA.

Remenyi, D. 2008 [ed.], *Proceedings of the 3rd International Conference on e-Learning Academic Conferences*, University of Cape Town, South Africa, 26 27 June 2008.

Rheingold, H. 1985, Tools for Thought: The History and Future of Mind-expanding Technology. MIT Press, Cambridge, Massachusetts.

Ribes, D., & Bowker, G. C. 2005, 'A learning trajectory for ontology building', *Annual Knowledge and Organizations Conference*, Long Beach, CA. 2005.

Richey, R., Fields, D. C., & Foxton, M. 2001, *Instructional design competencies: the standards*, ERIC Clearinghouse on Information and Technology, Syracuse, NY.

Rimpiläinen, S. 2012, *Gathering, Translating, Enacting. A study of interdisciplinary research and development practices in Technology Enhanced Learning*, PhD thesis , Sterling University, Scotland, viewed 9 November 2015, <https://dspace.stir.ac.uk/handle/1893/5051>

Robertson, D.N. 2005, *Self-Directed Learning – Past and Present*, University of Georgia, ERIC Clearinghouse on Information Sources, New York.

Rogers, Y. 2008, 'The Role of Mobile Devices in Facilitating Collaborative Inquiry in Situ', *Research and Practice in Technology Enhanced Learning*, vol. 3, no. 3, pp. 209–29.

Rose, G. 2007, *Visual Methodologies: and introduction to the interpretation of visual materials*, 2nd [ed.], Sage, London.

Russell, S., & Norvig, P. 1998, *Artificial Intelligence: A Modern Approach*, 2nd Int. edn., Person Education Limited, Harlow UK.

Saettler, P. 1968, *A History of Instructional,* McGraw-Hill, New York.

Salisbury, D. F. 1990, 'General systems theory and instructional systems design', *Performance + Instruction*, vol. 29, no. 2, pp. 1-10.

Salmon, G. 2013, *E-tivities: The Key to Active Online Learning*, Routhledge, Abingdon, Oxon.

Sargent, N., & Tuckett, A.1997, 'Pandora's Box?' *Companion papers on Motivation, Access and the Media*, NIACE, London.

Savage, M., Ruppert, E., & Law, J. 2010, *Digital Devices : nine theses*, CRESC Working Paper Series, Working Paper no 86, viewed 9th November 2015 <http://www.cresc.ac.uk/medialibrary/workingpapers/wp86.pdf>

Sawyer, R. K. [es.] 2005, *The Cambridge handbook of the learning sciences*, Cambridge University Press, Cambridge UK.

Scanlon, E., Sharples, M., Fenton-O'Creevy, M., Fleck, J., Cooban, C., Ferguson, R., Cross, S. & Waterhouse, P. 2012, 'Beyond prototypes Enabling innovation in technology-enhanced learning', *TEL-TLRP Programme Publication*, LKL IoE, London.

Schultz, L. M., Birmingham, E., Davy, K., Gold, D., L'Eplattenier, B., Mastrangelo, L., Nitecki, A., Sharer, W. B., Kirsch, G. E. & Rohan, L. 2008 , *Beyond the Archives: Research as a Lived Process*, Southern Illinois University Press, Illinois.

Sclater, N. 2014, 'Learning analytics The current state of play in UK higher and further education', *JISC publications Repository*.

Seale, C., Gobo, G., Gubrium, J. F., & Silverman, D. 2004, *Qualitative Research Practice,* Sage, London.

Seale, J., & Rius-riu, M. 2001, An introduction to learning technology within tertiary education in the UK, *Association for Learning Technology*, Bristol.

Seldon, A. 2007, *Blair's Britain, 1997-2007*. A. Seldon, [ed.], Cambridge University Press., Cambridge, UK.

Seldon, A., & Kavanagh, D. 2005, *The Blair Effect 2001-5*, in A. Seldon & D. Kavanagh, [eds.], Cambridge University Press., Cambridge, UK.

Selwyn, N. 2008, 'Designing the web for teaching and learning', *A Commentary from the Technology Enhanced Learning phase of the Teaching and Learning Research Programme,* TEL Programme Publication, LKL IoE, London.

Shaffer, D. W., & Clinton, K. A. 2006, 'Toolforthoughts: Reexamining thinking in the digital age', *Mind, Culture and Activity*, vo.13, no. 4, pp. 283-300.

Seppä, A. 2003, *The Aesthetic Subject Exploring the Usefulness of Foucauldian tools in Feminism*, Helsinki University Printing House, Helsinki.

Sharples, M., Milrad, M., Arnedillo Sanchez, I., & Vavoula, G. 2009, 'Mobile learning: Small devices, Big issues', in S. Balacheff, S. Ludvigsen, T. de Long, A. Lazonder, & S. Barnes [eds.], *Technology enhanced learning: Principles and products*, Springer, Heidelberg, pp. 233-49.

Shih, M., Feng, J., & Tsai Chin-Chung, C. 2008, 'Research and trends in the field of e-learning from 2001 to 2005: A content analysis of cognitive studies in selected journals', *Computers & Education*, vol. 51, no.2, pp. 955-967.

Silverman, D. 2006, Interpreting Qualitative Data: Methods for Analyzing Talk, Text and Interaction, 3rd edn, Sage Publications Ltd., London.

Simon, H. A., & Newell, A. 1958, 'Heuristic Problem Solving: The Next Advance in Operations Research', *Operations Research*, vol. 6, no. 1, pp. 1-10.

Sismondo, S. 2010, An Introduction to Science and Technology Studies. Wiley-Blackwell, London.

Skinner, B. F. 1958, 'Teaching Machines', *Science*, vol. 128, no. 3330, pp. 969-977.

Slater, M. D. 2002, Entertainment Education and the Persuasive Impact of Narratives, in J. J. Strange & C. Brock [eds.], *Narrative Impact: Social and Cognitive Foundations*, Lawrence Erlbaum, Mahwah NJ, pp. 157-18.

Slaton, J. 2001, 'Remembering Community Memory / The Berkeley beginnings of online community', *SFGate*, viewed 9 November 2015, <http://www.sfgate.com/news/article/Remembering-Community-Memory-The-Berkeley-2842143.php#page-1>

Sleeman, E. 2001, *The International Who's Who of Women 2002*, Psychology Press, London.

Smithers, A. 2005, 'UK Education Policy,' in A. Seldon (ed.), *The Blair Effect*, Little Brown, London, pp. 405–26.

Solomon, N., Patel, U. and Solkin, L. 2007, 'Reassembling learning contexts and learners'. *Fifth International Conference on Researching Work and Learning.* The Universities of the Western Cape and Cape Town, Cape Town South Africa 2-5 December 2007, Paper 292.

Sommerville, I. 2010, *Software Engineering* 9th [ed.], 9th edn, Addison Wesley, London.

Sommerville, I. 2010, *Software Engineering*, 9th edn, Addison Wesley, New York.

Sørensen, E. 2009, The Materiality of Learning: Technology and Knowledge in Educational Practice, Cambridge University Press., Cambridge, UK.

Spector, M. J., Merrill, D., & Elen, J. [eds.] 2012, *Handbook of Research on Educational Communications and Technology*, Routhledge, Abingdon, Oxon.

Squires, D., Conole, G., & Jacobs, G. 2000, *The Changing Face of Learning Technology Vol. 1*, University of Wales Press, Cardiff.

Stacey, A., & Stacey, A. 2004, Effective Information Retrieval from the Internet: An Advanced User's Guide, Chandos Publishing, Oxford.

Stahl, G., Koschmann, T., & Suthers, D. 2006, Computer-supported collaborative learning: An historical perspective, in R. K. Sawyer [ed.], *Computer-supported collaborative learning: An historical perspective*, Cambridge University Press, Cambridge, UK, pp. 409-426.

Steedman, C. 2002, *Dust The Archive and Cultural History*, Rutgers University Press, New Brunswick.

Stepney, S., Abramsky, S., Adamatzky, A., Johnson, C., & Timmis, J. 2008, *Grand Challenge 7 : Journeys in Non-Classical Computation*, viewed 9 November 2015, <http://www.bcs.org/upload/pdf/ewic_vs08_s11paper1.pdf>

Stich, S. 1985, *From Folk Psychology to Cognitive Science: The Case Against Belief*, MIT Press, Cambridge, Massachusetts.

Strathern, M. 1996, 'Cutting the network', *Journal of the Royal Anthropological Insitute,* vol. 2, no. 3, pp. 517-535.

Strathern, M. 2004, *Commons and Borderlands: Working Papers on Interdisciplinarity, Accountibility and the Flow of Knowledge*, University of Virginia: Sean Kingston Publishing.

Suchman, L. 2002, Located accountabilities in technology production, *Scandinavian Journal of Information Systems*, vol.14, no. 2, pp. 91-105.

Suchman, L. A. 1987, *Plans and Situated Actions: The Problem of Human-Machine Communication*, Cambridge University Press, Cambridge UK.

Suchman, L. A. 2007, *Human-Machine Reconfigurations: Plans and Situated Actions*. Cambridge University Press, Cambridge UK.

Suppes, P. 1966, The Uses of Computers in Education, *Scientific American*, vol 215, no. -, pp. 206-220.

Sutcliffe, A., & Patel, U. 1996, '3D or not 3D: is it nobler in the mind?' in M. A. Sasse, R. J. Cunningham, & R. Winder [eds.], *People and Computers XI, Proceedings of HCI-96* Springer Verlag, pp. 79-93.

Sutherland, I. E. 1963, 'SketchPad: A man-machine graphical communication system', in *AFIPS Conference Proceedings,* May 21 -23, pp. 323-328.

Sutherland, I. E. 1959, Sketchpad, a man-machine graphical communcaiton system. Technical Report Number 574, University of Cambridge Computer Laboratory, Cambridge UK.

Sutherland, I. E., & Ullner, M. K. 1984, 'Footprints in the Asphalt', *The International Journal of Robotics Research*, vol.3, no. 2, pp. 29-36.

Sutherland, R., Eagle, S., & Joubert, M. A. 2012, A Vision and Strategy for Technology Enhanced Learning: Report from the STELLAR Network of Excellence, STELLAR Network of Excellence 2012.

Szpakowski, M. 2006, 'Community Memory 1972 - 1974, Berkeley and San Francisco, California', *Creative Commons Attribution Share-Alike*. viewed 9 November <http://www.well.com/~szpak/cm/index.html>

Tatnall, A. [ed.] 2012, Reflections on the History of Computing: Preserving Memories and Sharing Stories Vol. 28, Springer, Melbourne.

Taylor, J., Rodden, T., Anderson, A., Sharples, M., Luckin, R., Conole, G., Siraj-Blatchford, J. 2004,. *An e-learning research agenda*, ESRC Publication online, London.

TEL call for funding document 2006, *Understanding , creating , and exploiting digital. Research on Technology Enhanced Learning, Call for Research Proposals*, issued by ESRC/EPSRC, viewed 9 November 2015, <http://www.tlrp.org/manage/documents/CALLTELfinal-1.pdf>

TEL call for funding document 2007, *Understanding , creating , and exploiting digital. Research on Technology Enhanced Learning, Call for Research Proposals*, issued by ESRC/EPSRC, viewed 9 November 2015, < http://www.tlrp.org/manage/documents/TLRP%20Secondcall%20(FINAL).pdf >

TeLearn Technology-enhanced Learning 2006, European Commission, viewed 9 November 2015, <ftp://ftp.cordis.europa.eu/pub/ist/docs/telearn/telearn-leaflet_en.pdf>

The Becta Review Evidence of progress of ICT in education 2006, *British Educational Communications and Technology AgencyBecta,* Becta ICT Research, London.

Thomas, J., & Harden, A. 2008, 'Methods for the thematic synthesis of qualitative research in systematic reviews', *ESRC national Centre for Research Methods NCRM Working Paper Series Number 10/07.*

Thompson, T.L. 2015, 'Digital doings: curating work–learning practices and ecologies', *Learning, Media and Technology*, vol. 9884, no. September, pp. 1–21.

TLRP-TEL. 2012, 'Inventing the Future of Learning', *YouTube Video*, Technology Enhanced Learning Programme UK 2007-2012, viewed 9 November 2015, <https://www.youtube.com/watch?v=8FBC496ggF0>

Toennesen, C. 2005, 'Toward Non-Deterministic Foundations for Studying Technology in Organisations – A Literature Review,' *CERN IT Openlab Programme,* Researchgate database.

Tomlinson, S. 1996, *Tomlinson Report. Inclusive learning: Report of the Learning Difficulties and/or Disabilities Committee*, Government Stationery Office, London.

Tonkiss, F. 2004, 'History of social statistics and social survey'in n C. Seale [ed.], *Researching Society and Culture*, 2nd edn, Sage Publications Ltd, London, pp. 85-98.

Traweek, S. 2004, Generating High Energy Physics in Japan: Moral Imperatives of a Future Pluperfec, in D. Kaiser [ed.], *Training Scientists, Crafting Science: Putting Pedagogy on the Map for Science Studies*, MIT Press, Cambridge, Massachusetts.

Tsai, C. C., & Wen, L. M. C. 2005, 'Research and trends in science education from 1998 to 2002: A content analysis of publications in selected journals', *International Journal of Science Education*, no. 27,vol. 1, pp. 3-14.

Tscholl, M., & Carmichael, P. 2011, 'Cases, Simulacra and Semantic Technologies', *Journal of Computer Assisted Learning*, vol. 29, no. 1, pp. 31-42.

Tu, C. H., & Twu, H. L. 2002, 'Educational Technology in Taiwan', *Educational Media International*, vol. 39, no. 1, pp.153-164.

Turing, A. M. 2004, 'Computing Machinery and Intelligence', in S. Shieber [ed.], *The Turing Test*, MIT Press, Cambridge, Massachusetts, pp. 67 – 97.

Turkle, S. 1984, *The second self: computers and the human spirit*, Simon Schuster, New York.

Turner, F. 2006, *From Counterculture to Cyberculture: Stewart Brand, the Whole Earth Network, and the Rise of Digital Utopianism*, University of Chicago Press, Chicago.

Underwood, J., & Luckin, R. 2011, 'What is the AI in AIED for ?' *TEL-TLRP Programme Publication*, LKL IoE, London.

Verran, H. 2007, 'Metaphysics and Learning,' *Learning Inquiry*, vol. 1, no. 1, pp. 31–9.

Vincenti, W. G. 1990, What engineers know and how they know it: Analytical studies from aeronautical history, Johns Hopkins, Baltimore.

Voithofer, R., & Foley, A. 2002, 'Post-IT: Putting postmodern perspectives to use in instructional technology—A response to Solomon's "Toward a Post-Modern Agenda in Instructional Technology." ', *Educational Technology Research and Development*, no. 50, vol. 1, pp. 5-14.

Waltz, S.B. 2006, 'Nonhumans Unbound: Actor-Network Theory and the Reconsideration of 'Things' in Educational Foundations', *Educational Foundations*, vol. 20, no. 3-4, pp. 51–68.

Wenger, E. 1998, *Communites of Practice: Learning, Meaning and Identitiy,* Cambridge University Press, Cambridge, UK.

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

White, D., Warren, N., Faughnan, S., & Manton, M. 2010, 'Study of UK Online Learning Final report, March 10', *Commissioned by the UK Higher Education Funding Council (HEFCE),* University of Oxford, Oxford.

White, S., & Liccardi, I. 2006 ,. Harnessing Insight into Disciplinary Differences to Refine e-learning Design, in *Proceedings. Frontiers in Education. 36th Annual Conference,* IEEE, pp. 5-10.

Whittle, A. 2008, 'Is Actor Network Theory Critique?,' *Organisation Studies*, vol. 29, no. 4, pp. 611–29.

Whitty, G. 2006[49], 'Education (al) , research and education policy making: is conflict inevitable?' *British Educational Research Journal*, vol. 32, no. 2, pp. 159-176.

Whitworth, A. 2005, 'Researching the cognitive cultures of e-learning', in *Exploring the frontiers of e-learning: borders, outposts and migration - Proceedings of ALT-C 2005,* University of Manchester, 6-8 September.

Wilson, T. D. 2002, 'The nonesense of "knowledge management', *Information Research*, vol. 8, no. 1, paper 144.

Wirth, N. 2008, 'A Brief History of Software Engineering', *IEEE Annals of the History of Computing*, vol. 30, no. 3, pp. 32-39.

Wong, D. 2007, 'A Critical Literature Review on e-Learning Limitations', *UCSI JASA Journal for the Advancement of Science and Arts (Science & Technology Issue),* vol. 2, no. 1, pp. 55 62

Woolley, David, R. 1994, 'PLATO: The Emergence of On-Line Community', *Computer-Mediated Communication Magazine*, vol. 1, no. 3, July 1, 1994, p. 5, viewed 9 November 2015, <http://www.december.com/cmc/mag/1994/jul/plato.html>

Wright, P. M., & McMahan, G. C. 1992, 'Theoretical Perspectives for Strategic Human Resource Management' *Journal of Management Studies*, vol. 18, no. 2, pp. 295-320.

Wright, S. & Parchoma, G. 2011, 'Technologies for learning ? An actor-network theory critique of ' affordances ' in research on mobile learning', *Research in Learning Technology*, vol. 19, no. 3, pp. 247–58.

Wurster, C. 2002, *Computers: An Illustrated History*, Taschen, New York.

Wurster, C. 2002, Computers: An Illustrated History, Taschen.

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[49] This is a version of the speech that was the Inaugural Presidential Address to the British Education Research Association at the University of Glamorgan, September 2005.

Yates, L. 2004, *What does Good Education Research look like?,* Open University Press, Maidenhead, England.

Yates, L. 2005, 'Is impact a measure of quality? Producing quality research as producing quality indicators of research in Australia', in *Keynote address for AARE Focus Conference on "Quality in Educational Research: directions in policy and practice."* Cairns, July.

Yeaman, A. R. J., Anderson, J. H., Damarin, S. K., Me, R., & Ndrew, F. A. 2001, Postmoden and poststructual theory, in D. H. Jonassen [ed.], *Handbook of Research for Educational Communications and Technology* , AECT., Bloomington IN , pp. 1-47.