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A Dialogue and Social Software Perspective on Deep Learning Design

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Abstract: This article considers projects in Technology Enhanced Learning (TEL) that have focussed on designing digital tools that stimulate and support dialogue rich learning. These have emphasised collaborative thinking and meaning making in a rich and varied range of educational contexts. Technically, they have exploited AI, CSCL and HCI techniques, and ongoing projects are incorporating social software and semantic technologies. To address the particular challenge of extending this line of work within the Web 2.0 landscape and beyond, where the pace of technological change is profound, we will introduce the original notion of Deep Learning Design (DLD). This is a paradigm that we hold is important to both better understanding and realising learning in the digital age that counters the sort of technological determinism that is unhealthy for the field of learning. So this article will: consider the current challenges of designing dialogue rich learning; explain why the challenges raised necessitate the introduction of an original conceptualisation of design; and, exemplify and map this new notion of design to two large-scale TEL initiatives. These are projects in Digital Dialogue Games (DDGs) and MATURE: Continuous Social Learning in Knowledge Networks, where in the latter the focus is on a particular strand of research that brings both projects together. Finally some implications are considered and some conclusions are drawn.

Keywords: Dialogue, Thinking, Deep Learning Design (DLD), the Web, Context.

1. Introduction: Dialogue, Social Software and Deep Learning Design

How does, or will, the increasing prevalence of the social and media-rich web, or Web 2.0, and its related rapid changes in technological possibilities, influence the ways we communicate, think and learn? Although this is clearly a wide-ranging question, this article will propose an original, contemporary and holistic approach within Technology Enhanced Learning (hereafter TEL), of Deep Learning Design (hereafter DLD), that is suitable for the digital age. Through adopting this stance we will argue against agendas predicated on (constantly changing) technological possibilities that often blind the TEL community. Instead, we will argue that advances in both understanding and realizing contemporary learning and meaning making will be achieved through considering human communication and cognition in context alongside the possibilities offered and supported by the web and related digital technologies.

Cognition and its related notions of knowledge, reasoning and understanding have, arguably, been neglected within our field in recent years, due to an inordinate emphasis on 'what the latest technologies can do'. We hold that better understanding the links between cognitive and social dimensions of learning (e.g. Wegerif, Mercer & Dawes, 1999; Ravenscroft, 2004; Kirschner, 2006; Ravenscroft, 2010) will support real advances in both understanding and realising learning and intellectual development in the digital age, within individuals and throughout communities. Also, current trends in the development of digital literacies amongst students suggest the necessity to reconfigure pedagogical processes within more participative and collaborative engagements that are focussed on particular contexts (e.g. Ravenscroft et al., 2009; Hatzipanagos & Warburton, 2009).

This line of argument, that incorporates an emphasis on interaction in context, will be justified through over a decade of research at the interface of learning dialogue and digital technology development, which is arguably the most profound arena in which to examine these issues. This is because language and dialogue are the most direct and tangible window onto our key cognitive processes that support learning. It is predominantly through dialogue and discourse that is typically *dialogic* and *dialectic* in nature (Ravenscroft, Wegerif and Hartley, 2009), that we express what we think, change what we think, and better understand ourselves and others through the process.

Interestingly, as Ravenscroft, McAlister and Sagar (2010) have recently pointed out, this argument for reasoned dialogue and discourse is occurring amidst grave concerns within the education community about the lack of criticality on the web, and the 'dumbing down' of intellect through increased plagiarism, distracting communication and the general prevalence of 'cut and paste' practices amongst students.

> "…there is the fear that, in cyberspace, many students are encouraged to originate less and think less. This is combined with a relatively older and ongoing challenge of getting students, through dialogue, to think and think together in reasoned and intelligent, or 'scholarly', ways in online contexts."
>
> Ravenscroft, McAlister and Sagar (2010)

Ravenscroft, McAlister and Sagar (2010) also pointed out that research and practice have shown that achieving such 'scholarly discourse' has been a significant problem with the gamut of relatively recent communicative media - including conferencing, chat and social

software (e.g. see Ravenscroft, 2009; Ravenscroft, 2007; McAlister, Ravenscroft and Scanlon, 2004). Similarly, linking learning dialogues, where they do occur, to related pedagogical practices, such as academic writing, is another significant problem. These are the problems that a multi-partner initiative into *Digital Dialogue Games* (hereafter DDGs, see www.interloc.org) addressed, that we will use as the first example of how we followed the DLD paradigm through a raft of successful TEL projects. These projects developed, implemented and evaluated a 'state-of-the-art' collaboration and specialised social software tool (InterLoc) and its related learning activities (Digital Dialogue Games). Essentially, InterLoc stimulates and supports *reasoned learning and thinking* on the net and provides re-usable learner generated content (called Collaborative Thinking Texts) - that are textual representations of collaborative thinking that can be incorporated into related learning and teaching activities and used in various ways.

A Second line of work that we will use to demonstrate and exemplify DLD has been performed on a multi-partner EC funded project called "MATURE: Continuous Social Learning in Knowledge Networks" (see www.mature-ip.eu). This is investigating and promoting *informal learning* as *knowledge maturing* in the work-place, through designing learning rich spaces that leverage off relatively naturalistic and embedded communicative, semantic and knowledge-based processes. The intermediate outcome of the application of this approach, in advance of developing a Personal Learning and Maturing Environment (PLME) and Organisational Learning and Maturing Environment (OLME), is a federation of four Demonstrators linked to authentic user scenarios. We have also completed a comprehensive formative evaluation (Ravenscroft et al., 2010b) that has assessed these, collectively, in terms of their usability and suitability within authentic working contexts and how they can realise informal learning as a process of knowledge maturing.

So this approach of Deep Learning Design has been borne out of a re-interpretation of previous successful TEL research (e.g. see Ravenscroft 2007 for a review) and ongoing work in this field that is particularly challenged by designing learning in the Web 2.0 landscape and beyond (e.g. MATURE project; Ravenscroft & Boyle, 2010). As Ravenscroft et al., (2010a) pointed out:

> "…, the Deep Learning Design framework is a way of thinking about TEL design and development, and a set of guiding principles for planning, running and assessing TEL projects. In a sense, it could be argued that it 'packages up' some existing and recent notions of good practice, based on successfully executed projects that have led to sustainable innovations…However a key contribution is that it specifies this proposed practice in a clear and unambiguous way that also supports comparisons across projects. So applying this framework to TEL projects supports the straightforward identification of conformance to, or violation of, principles and practices that have been shown to lead to successful and sustainable TEL innovations."
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> Ravenscroft, Boyle, Cook & Schmidt, A. (2010a), p 579.

In this article we considerably develop the work that has been described in Ravenscroft et al., (2010a) and Ravenscroft and Boyle (2010), which has been applied to TEL in general, and also focus on dialogue and social software for learning.

We define and articulate 'design' as a set of principles, a process and its resulting artifacts, and below we provide additional justification for DLD, and differentiate it from Design-based research more generally, before introducing the principles.

2. Why Deep Learning Design?

Why are we interested in, and how do we characterise, 'deep learning design'? The approach is quite distinct from that based on the IMS-LD specification, where a concern with technical conformance to interoperability has moved the design focus from where it should be - on the enhancement of deep learning (e.g. Lockyear et al., 2009). In contrast DLD is a research and development driven approach for designing contemporary learning, that adopts a more humanistic and also holistic stance that incorporates an emphasis on the learner's *active processes and experiences within practices performed in contexts.* This framework, or approach, has some similarities with Design Based Research (DBR), (see Design Based Research Collective, 2002; Sandoval & Bell, 2004; Wang & Hannafin, 2005), but has some key differences, that make DLD an arguably more easily understandable and usable approach for promoting and assessing technology-enabled learning in the 21C. Hanafin and Wang (2005) comprehensively propose how DBR can be applied to TEL, through nine principles. These range from 'set practical goals for theory development' and 'analyse data immediately, continuously, and retrospectively' to 'validate the generalisability'. In contrast DLD is deliberately more focussed and selective in its key principles that leverage around social, contextual and communicative practices that occur through the embedding of socio-technical learning applications. So, we could articulate DLD as an adaptation and deliberate biasing of DBR towards the highly social, contextual and embedded learning, and also say that it is particularly in line with connectivist thinking (Siemens, 2005; Ravenscroft, 2010). But perhaps its most important overarching orientation is the emphasis on understanding and designing for the complexity of context. So the approach strongly proposes: designs linked to theories, new technologies and contexts of use; empirical evaluation according to sound pedagogical frameworks; and, the prescriptive imperative that we want to change learning for the better.

2.1 Theoretical and conceptual foundations

Why do we want to incorporate or advance theory or conceptual foundations in our TEL designs? Firstly, there is a strongly held view throughout the TEL community that applications should be properly informed by, or even realise, a learning theory or pedagogical framework, and without this, they aren't TEL designs. Instead they are simply interaction designs. Secondly, and perhaps most obviously, relevant theories have powerful potential to guide design and therefore instantiating them through technology will increase the likelihood of a TEL interaction leading to desired improvements in learning. Thirdly, which is related to the points below about opposing pure technological determinism, is that a theory, like a design, does not have to be technology dependant. So adopting a theoretical stance means that we can appropriately articulate technology to realise a more wide-ranging and often proven approach to learning, rather than adopting one that is simply doable through current or emerging technology. Fourthly, as the saying goes, 'nothing is as practical as a good theory'. Theoretical foundations will usually imply designs and allow us to formulate sound and relevant evaluative frameworks.

2.2 Design as the key development activity

Given the pace of change of the technological possibilities that support learning, we need to focus on a more future-proof notion than the technologies themselves to assist us in both better understanding and realising learning. *We argue, that 'design' is a suitably rich, flexible and yet formal enough concept and process to help us to engineer, or at least favour, better*

learning whilst also supporting better understanding of the processes at play. This stance is partly a reaction to research in the TEL field that has been overly predicated on technologies, where often there are Journals dedicated to this emphasis. These have included technological paradigms such as Artificial Intelligence in Education (e.g. Intelligent Tutoring Systems), Multimedia (e.g. Situated and Immersive Simulations), Computer Supported Collaborative Learning (e.g. using Communicative software and the internet) and more recently Mobile Learning, Serious Games and Augmented Reality. It is interesting and important to note that, for each technological wave, often prestigious researchers and research centres have advocated these as being imbued with great transformative powers that will address the fundamental problems with learning. But as yet, none of these revolutions have occurred, and worse, our collective memory is so poor, that we quickly jump onto the next technological bandwagon without learning lessons from the one we were previously riding. A related issue is what we could call - a 'magic elixir syndrome'. A metaphor which captures the way in which both the politicians who drive policy and researchers attempting to satisfy political and societal aspirations are often looking for that paradigmatic 'quick fix' that will make education and learning cheaper, better and more accessible to all. But, judging from the history of our field, learning is so inherently complex and varying across people and contexts that technological determinism by itself is unlikely to improve learning or easily address societal challenges in this respect.

2.2.1 Avoiding false dichotomies

Related to the above, a lot of TEL research that is technology led, promotes debate around false dichotomies because technologies can prejudice particular stances, so we have: student-centred or tutor-centred, personalised or institutional, individual or collaborative, informal or formal, mobile or location based, etc. Some of these dichotomies are captured, for example, by the Personal Learning Environment (PLE) *vs*. the organisationally focussed Virtual Learning Environment (VLE) debate. But in reality learning will occur through an orchestration of practices within a mixed economy of these dimensions. For example, we will always learn through being alone and together, and may use a combination of personal and organisational technologies to learn through informal and formal activities. Again, a focus on 'design' is a powerful orienting process that allows us to consider the optimal orchestrations of practices across technologies, compared to a more purely technological emphasis that typically prejudices one stance over another.

2.3 Foregrounding the role of context

Fundamentally, DLD is focused on designing enhanced contexts for learning. Boyle (2002) argues that context is "the natural base concept for the learning technologist (p. 6)". Context, he argues, must be treated not as a vague social backdrop to action. It is rather, 'an abstract representation of the relevant environment' (Halliday 1975). Support is quoted from a number of disciplines to establish the salience and centrality of this concept, including linguistics (Halliday 1975; Coulthard 1985), film theory (Hodges and Sasnett 1993) and psychology (e.g. Donaldson 1978; Bruner 1990). The construct is 'inter-psychic' - it is recognised by individuals and socially agreed upon. This construct then guides appropriate, adaptive interaction in that situation. The central challenge for TEL designers is to create enhanced contexts that promote effective learning.

Hammond (1993) argues that psychology has revealed considerably more about the contextual factors that influence learning than about the underlying cognitive processes

involved. The role of the learning technologist is to exploit this knowledge from psychology and the social sciences to construct contexts that promote effective learning. As deep learning design is essentially about the design of contexts for learning, the technology provides affordances and constraints in the type of contexts that we can create (Conole & Dyke 2004; Boyle & Cook 2004). However, the *design* of these contexts for learning should be driven not by the technology but by principles for enhancing learning derived from the relevant disciplines. All too often 'design' is limited to the basic affordances of the technology, with very limited creative thought about how to most effectively exploit and orchestrate these affordances. Thus in Second Life, for example, the potential 3 dimensional immersive experience, all too often, is used to provide movement through a dull landscape of virtual lectures or 2D slide shows.

Design is about the most effective way to exploit the technological affordances to foster learning. Principles and techniques, e.g. such as scaffolding (Bruner 1975), provide deep insights into how to develop effective learning contexts (see the dialogue game and InterLoc example later in this article). And although in this article we are emphasising sociality and dialogue, these principles and techniques are generic (see Ravenscroft & Boyle, 2010; Ravenscroft et al., 2010a). They apply whether the technology is social or individually focused.

There remains an important process of translating these deep principles to meet the opportunities and constraints offered by particular technology - good design is always creative. But the core of the creativity is matching a deep understanding of learning to the technological possibilities - good design never arises automatically from the availability of the new technology. This paper provides two major exemplars of how effective learning design uses the potential of technologically mediated contexts to enhance learning.

The Interloc tool, described in section 3 of this paper, illustrates how good design builds on, and enhances technological possibilities. Online 'chat' systems provide possibilities for learning through dialogue. However, the actual chat produced often degenerates into low-level, fragmented conversation (McAlister, Ravenscroft & Scanlon, 2004; Herring, 1999). InterLoc enhances the learning potential of these situations by introducing scaffolded exchanges, and structuring these into coherent 'dialogue games' (see Figure 1). *Good design does not just follow the affordances of the technology. It exploits these affordances within a design framework that enhances learning* .

A corollary of these points above is that in contemporary learning contexts TEL design needs to emphasise the ecological validity of the actual contexts for learning. This consideration includes: the relevance and richness of learners' experience, and interaction and processes that are mediated by technologies (and not necessarily dictated by them). These factors must be related in an authentic way to practices in the wider environment (Cole 1996), including the increasing prevalence of digitally-mediated practices interwoven with our everyday behaviour.

2.4 Evaluation linked to theoretical or conceptual frameworks and real problems within contexts

A final key element of DLD is the adoption of an evaluative framework linked to the theoretical and conceptual foundations and the contexts of use, that also directly feeds into ongoing design processes. In contemporary learning contexts, to cover both ecological validity and reproducible empirical rigour, the development of a suitable framework can be

very challenging and involve qualitative and/or quantitative methods. But, the key point is that, whatever methods are adopted, they should be appropriate in addressing the key assumptions or claims made about the design (e.g. whether it does improve learning in some measureable way) and not just superficial characteristics (e.g. numbers who have used a design and/or anecdotal opinions from selected users).

2.5 Summarising the principles of DLD

The above can be summarised, through synthesising some of the Sections above, as DLD is a framework which proposes that TEL research and development incorporates:

1. A contemporary articulation of appropriate *theory,* or suitable *conceptual framework*;
2. Design that is not predicated on latest technologies but does *clearly operationalise the functionalities and affordances* of these technologies;
3. Learning as *interaction in context*;
4. An *evaluative approach* linked to the theoretical or conceptual foundations and the design process.

Two examples of how this approach of DLD has been adopted to tackle significant TEL problems, namely of supporting collaborative and critical thinking and learning on the web, and supporting continuous social learning in work-based knowledge networks are described below. The Digital Dialogue Game (DDG) initiative has been supported by various projects over the past decade and the EC Integrated Project - MATURE: Continuous Social learning in Knowledge Networks is ongoing. Although the emphasis in this article will be given to the DDG project, which included substantial and completed evaluations, it is important to point out how the DLD approach has been scaled-up and applied within the larger scale MATURE project, that has just completed its formative evaluation phase (Ravenscroft et al., 2010b). The latter project includes recent dialogue game developments that clearly justify the longevity and flexibility of this particular design paradigm.

3. Digital Dialogue Games: A DLD for thinking together and thoughtful writing

In conceptualising TEL interaction design as DLD, we will begin with explaining the role and importance of designs related to learning dialogue. Dialogue is arguably the primary mechanism which links communication, cognition and context within education, and therefore supports thinking and learning in collaborative situations (Mercer, 2000, Ravenscroft, 2004, Wegerif, 2007; Ravenscroft 2010). As Ravenscroft, McAlister and Sagar (2010) have pointed out about dialogue:

> "…although its form and means of realisation are changing through the increased prevalence of highly participative and discourse intensive social software, or web 2.0, technologies, some underpinning pragmatic level, or deep and social, discourse processes are arguably more stable and still at play. For example, we will always use dialogue, as our most intuitive semiotic system, to articulate and express what we think, share our thoughts and ideas with others, and collaboratively create meaning and understanding to make joint inquiries or solve common problems. We may be doing these things in more immediate, participative or multimodal ways, but the deep psycho-social imperatives are more impervious to change."

This position is exemplified by our work with Digital Dialogue Games (DDGs) and InterLoc that has been presented in detail in other articles (e.g. Ravenscroft and McAlister, 2008; Ravenscroft, McAlister & Sagar, 2010). In this Section we map this dialogue game initiative to the principles of DLD.

3.1 Theoretical and conceptual foundations

Theoretically, the DDG approach is driven by Vygotskyan (1978) and Bahktinian (1986) notions of conceptual development that have informed a contemporary articulation of *dialogic* and *dialectic* dimensions of learning dialogue (Ravenscroft, Wegerif & Hartley, 2007). These are realised within interaction designs that build upon the well-attested approach of 'dialogue games' (Levin & Moore, 1977 ; MacKenzie, 1979 Walton, 1984) and also make use of Speech Act theory (Searle, 1963). This has been reported extensively in previous articles (see Ravenscroft 2007 for a review) and recently articulated through a dialogue-rich approach to Siemens (2005) theory of *connectivism* (Ravenscroft, 2010). These notions are complemented and realised through applying original conceptual principles of 'ambient pedagogy' and 'experience design' (Ravenscroft et al., 2008). In succinct terms: ambient pedagogy holds that the structure or scaffolding supporting the learning interaction is 'behind the scenes' and yet also implicit in the digital practice that is supported; and, 'experience design' emphasises that the learning occurs through the production of an experiential context, or 'space' that favours learning, in contrast to foregrounding the management of instruction and pedagogical design.

3.2 The design approach

The DDGs are by their nature a flexible design paradigm that have been implemented using various technologies over the past ten years, spanning Artificial Intelligence in Education (AIED), Computer Supported Collaborative Learning (CSCL) and now more recently social gaming and other social software technologies. This trajectory of related research and development is described in detail in Ravenscroft (2007) and Ravenscroft and McAlister (2008).

These game designs and tools are developed through modelling key social and pragmatic level features of effective dialogue interaction, in ways that are described detail in Ravenscroft and Pilkington (2000). These features include the roles of the interlocutors (e.g. learning manager, facilitator, player), the ground rules for commitment and turn-taking, and the type of speech-acts (Searle, 1969) that may be performed (e.g. Assertion, Question, Challenge). The dialogue games that are developed, whilst sharing the same categories of features (e.g. pre-defined goals, numbers of players, roles, moves and rules, etc.) are distinctive in terms of the specifics and configurations of these features. They are also different in terms of the particular learning problems they address and the learning processes they support (e.g. critical, creative or exploratory dialogue) whilst retaining certain 'family resemblances' (Wittgenstein, 1953). The methodology has been successfully used to design a number of digital dialogue game tools (e.g. DIALAB, CoLLeGE, CLARISSA, AcademicTalk and InterLoc).

The latest tool (e.g. InterLoc5) has also incorporated the new concepts of 'ambient pedagogy' (realised through ambient learning designs) and 'experience design' whilst also considering recent research into more personalised approaches to learning design that are suitable for the digitally literate learner (Ravenscroft and Cook, 2007) and their widespread use of social software.

3.2.1 The InterLoc(v5) Tool

This sub-section describes the design of InterLoc(v5) to demonstrate how this project followed and operationalised the principles of DLD. This tool is described in detail in Ravenscroft, McAlister and Sagar (2010) and is summarised below for the purposes of this paper.

The key features of the dialogue game and InterLoc DLD are:

1. Configurable learning activities that link web-resources to, also configurable, dialogue games;
2. Interaction as a social game involving 4-6 players, where the learning design introduces: a model of turn-taking; a distinctions between Contributing to the whole dialogue and Replying to a particular contribution; Pre-defined Move categories (e.g. *Assertion, Question, Challenge*) and Locution Openers (e.g. *"I think…", "I disagree because…", "Let me explain…"*) to perform the dialogue;
3. Rules of interaction to guide fair and reasonable responding (e.g. in the simplest case replying to a Question Move will list Assertion openers);
4. Dialogue Game as both a conversation and re-usable resource, known as a Collaborative Thinking Text.

The interface in Figure 1 and 2 shows how each player performs the dialogue game (where the actual names of the participants are anonymised through being given 'dummy' names conveying the same gender). Through modelling natural (non digital) discussions, a fundamental distinction is made between "Contributing" to the developing dialogue (using the large reply bar at the bottom), typically responding to the latest 'state of the dialogue', or replying to a specific previous contribution (by selecting "Reply" next to each contribution). 'Contributing' to the dialogue places a message at the bottom of the display while 'Reply' indents responses below the specific contribution that is replied to - preserving a thread. This design contains affordances that achieve a balance of 'keeping the dialogue moving forward' while also allowing coherent sub-conversations and reflective asides.

Figure 1 shows how all contributions or replies are made by selecting from a menu of pre-defined Move categories (*Inform, Question, Challenge* etc.) and then selecting specific locution openers to 'start' each utterance (e.g. *"Is there another way of looking at it…", "Why do you think that…" and "Why is it…"* from the drop-down menu on the left of Figure 1 and *"I disagree because…"* "*I'm not so sure…*" and *"Please give a reason…*" from the menu on the right).

Similarly, rules about the legitimate and logical responding openers, based on the specific Openers that are replied to, are offered selectively, as shown in Figure 1 by the responses offered to eny's *"I agree because…".* But note that these suggestions can be overridden through selecting "More" to reveal the complete set of Moves and Openers. So different and flexible degrees of scaffolding are provided, that tend to harmonise with the level argumentative competence of the players.

This player interface (Figure 1 and 2) shows how the adoption of familiar design features, such as icons showing who else is online and active, along with html, CSS and common design colours and idioms (e.g. threading, menu operation and expansion boxes) ensures the dialogue game experience is attractive and 'feels like' a typical and intuitive web experience. Therefore it supports a style of interaction that builds on students' experiences

with other familiar technologies like MSN and Skype. Also, the model of turn-taking is incorporated, that is indicated by the typing 'pac-man', to promote logically coherent, rather than sequentially incoherent, dialogue, and also 'listening' to others contributions.

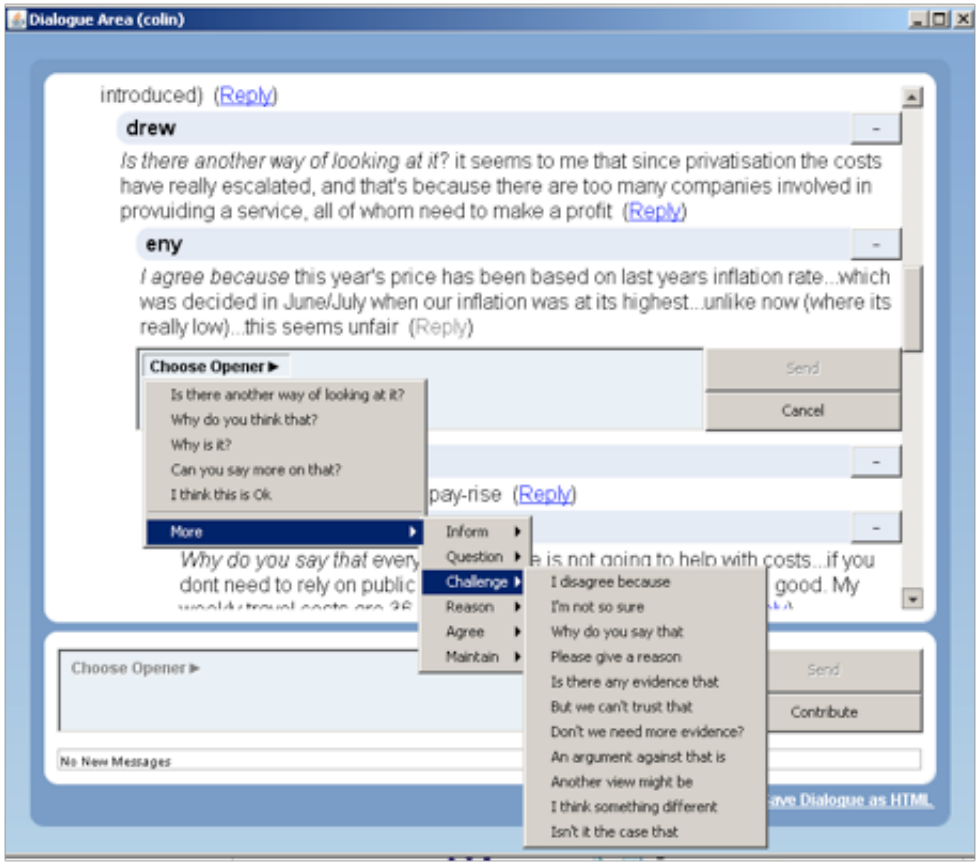

Figure 1: InterLoc(v5) interface showing how reasoned dialogue is scaffolded

The interchange in Figure 2 (of a sequence of coherent replies) is about the National Science Curicullum in the UK and involved PGCE Science students from a UK University playing a critical discussion and reasoning game. This activity is discussed in more detail in Ravenscroft McAlister and Sagar (2010). But even in this example we can see how InterLoc supported a critical inquiry dialogue involving probing inquiries*("I'm not so sure…"),* principled questioning *("Is it the case that…"*), the use of evidence (" *Let me explain…"*) and reasoned disagreement ("*I disagree because…").* So even this brief excerpt demonstrates:

1. How participants all contribute to the dialogue, to co-construct a well-balanced critical account;
2. Challenging ("*I'm not sure sure…", "I disagree because…"*), an Assertion *("Let me explain…"*) and Questioning ("*Isn't it the case that…"*) within the dialogue;
3. How the dialogue game allows the players to quite quickly identify, consider the importance of, and then elaborate their understanding of a key concept - the role of coursework and,
4. How each participant, at this stage of the game, is articulating their own and varying understandings of how this concept (of coursework) relates to a curriculum and independent research.

To achieve these processes and practices we have also 'made the complex look and feel simple', through rendering a relatively complex learning design (McAlister, Ravenscroft & Scanlon, 2004) into a more attractive 'experience design', that is similar to popular dialogue and social software technologies that are familiar to students.

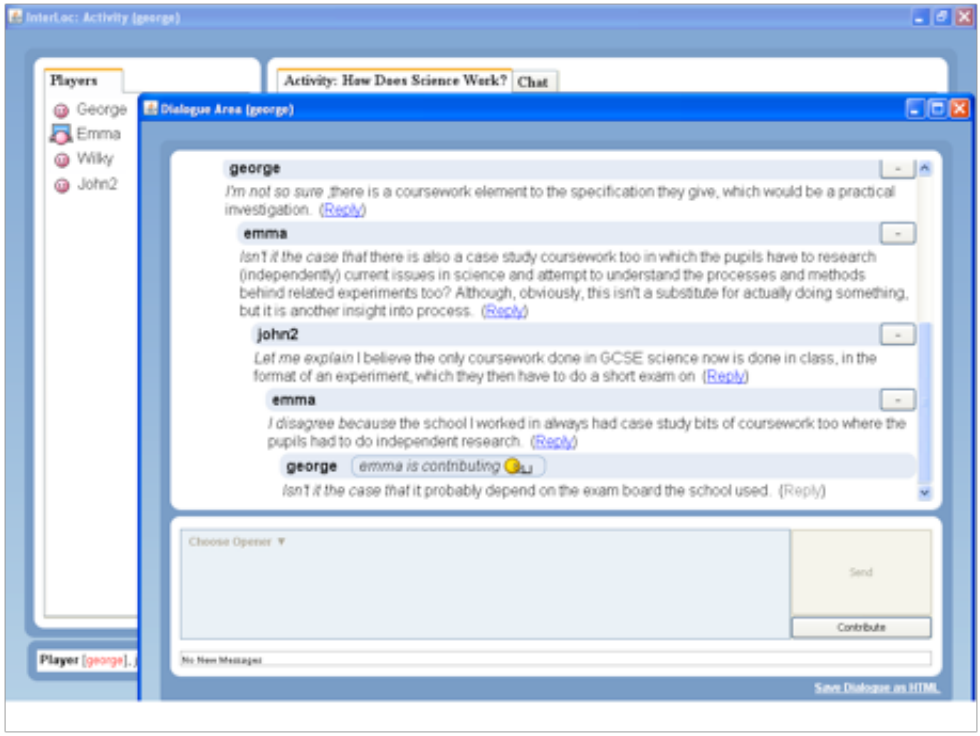

Figure 2: InterLoc(v5) interface during a Critical Discussion and Reasoning (CDR) game

3.3 Evaluative frameworks adopted

The DDG approach has proven efficacy for a range of learning problems and contexts, as documented in a range of research projects over the past ten years that are summarised in Ravenscroft (2007). Notably, the efficacy of dialogue games as the means to engineer conceptual change in science (Ravenscroft, 2000; Ravenscroft and Matheson, 2002) and promote improved reasoning and argumentation skills (McAlister, Ravenscroft and Scanlon, 2004; Ravenscroft & McAlister, 2008) has been proven through a number of empirical investigations that were performed alongside technical developments.

The positive findings that emerged from all these studies that ranged from small-scale laboratory investigations, comparative experimental studies in the field (i.e. a school) and quasi-experimental studies in authentic settings (on distance learning courses) are summarised in Ravenscroft & McAlister (2008). These led to considerable improvements in the design and implementation of the DDGs and InterLoc that have recently been deployed and evaluated within an action research project across five HE Institutions, with over 350 students and 10 tutors. This most recent evaluation, that provided the 'acid test' as to whether the approach of DLD that was followed did in fact produce a TEL application that is highly innovative and can be implemented and used in authentic contexts is described in detail in Ravenscroft, McAlister and Sagar (2010), and is summarised below.

3.3.1 Latest Evaluation: Summary of five Case Studies of exemplary implementations

Five participating institutions performed exemplary implementations of the DDGs and InterLoc following the action research approach. These tested whether the approach was genuinely advancing: pedagogies for the digital age; learners thinking and meaning making on the net; and, the general adoptability of innovative dialogue technologies. They involved

using InterLoc through either incorporating activities into courses or by holding additional activities for volunteer students on course related topics. These ranged from first year undergraduates to research postgraduates; and from non-native speakers of English to post-graduate educators. Specifically, these implementations included computing and multimedia students, postgraduate science students, physics students, educational technology students and practicing Social Workers.

The different implementation contexts covered a range of purposes that led to a range of outcomes from the activities, including:

1. the generation of well thought-out ideas;
2. more engaging and higher quality interaction than had been previously possible;
3. writing and reasoning correctly in English;
4. diagnosis of misunderstandings of a Physics problem;
5. understanding and articulating the ways learning takes place;
6. integrating non-native speakers into a wider group;
7. critical discussions, with signs of conceptual change, on the science National Curriculum;
8. critical discussion on e-learning and assessment;
9. weighing evidence and judgments in Social Work.

In all these contexts, according to student and tutor appraisals and analysis of the transcripts, InterLoc performed well or very well, promoting thinking together, critical discussion and deeper argument linked to learning. These Case Studies are described in more detail in Ravenscroft et al., (2008) and an impressionistic summary taken from Ravenscroft, McAlister and Sagar (2009) is given below.

The focus in one study was on developing critical discussion around the Science National Curriculum and the transcripts showed that this was successful. These students responded with positive comments about sharing knowledge, fully exploring the subject, and thinking in more depth. A number were specific that using InterLoc challenged them to think critically and to think before contributing. Most felt they had learned something from their discussions. The transcripts of their gun-control discussions were used on one course as notes for an extended essay on the topic, which students were able to refer to whilst writing. These students went on to write reasonably well balanced discursive essays, compared to more disappointing results with students who had only face to face discussion. Follow up interviews with some students, using critical event recall, in conjunction with the transcripts, traced how they had come to change their mind or stance within a series of dialogue games. These findings, more generally, demonstrated how argument and critical reasoning through the DDGs could improve learning, or create new learning.

We hold that this example from the dialogue game and InterLoc approach clearly demonstrates how the application of DLD directly supports and promotes a *key learning process*, of *reasoned dialogue linked to thoughtful writing*. In the example below, we further justify and exemplify our approach through a related and yet less formal and more embedded approach to learning, that focuses on providing 'learning rich spaces' that support *informal learning and knowledge maturing* in the 'Web 2.0 work-place'.

4. DLD for Continuous Social Learning in Knowledge Networks

This Section will concisely describe how the DLD approach has been applied to a large-scale European project called "MATURE: Continuous Social Learning in Knowledge Networks" (www.mature-ip.eu). Here the broad design challenge is to develop a complex system incorporating a Personal Learning and Maturing Environment (PLME) and an Organisational Learning and Maturing Environment (OLME), that are realised through instantiations of configurations of distinctive services. We adapt and selectively summarise previous work that has reported the MATURE design methodology in more detail (Ravenscroft, Schmidt and Cook, 2010; Ravenscroft et al., 2011) and extend a briefer account given in Ravenscroft et al, 2010a). We will also show how some work on this project has incorporated a particular focus on digital dialogue through adapting the dialogue game approach in the context of social and semantic technologies for work-based learning, through selectively adapting and summarising work that has been described in Ravenscroft, Braun & Nelker (2010) and Ravenscroft et al., (2008).

4.1 Conceptual underpinnings for digitally mediated work-based learning

Central to MATURE is the idea that knowledge maturing will occur through engineering learning rich spaces within existing, technology mediated work-based contexts, and where this maturing follows particular phases (Maier & Schmidt, 2007). This is captured and documented in the 'knowledge maturing model' (Kaschig et al., 2010) that emphasises notions of continuously changing and alive contexts, and which by its nature, leverages off knowledge workers situated activity and related emergent processes and assets. According to Schmidt (2008), *knowledge maturing* is " *the advancement of knowledge (i.e. learning) on a collective level and where it becomes less contextualized, more explicitly linked, and easier to communicate*" . The model organises this process into five phases: 1) *Expressing ideas*, in which new ideas are developed by individuals from personal experiences or in highly informal discussions, 2) *Distributing in communities*, in which a common terminology that is shared among community members is developed, 3) *Formalizing*, in which hitherto created artefacts are transformed from being inherently unstructured to being more purposive and structured, 4) *Ad-hoc learning*, in which material is prepared in a pedagogically sound way, enabling broader dissemination, 5) *Standardization*, in which individual learning objects are put together to cover a broader subject area, and thus become teachable to novices.

Ravenscroft, Braun and Nelker (2010) have argued how the role of dialogue, and its links to semantic technologies is seen as critical to this maturing process, so this was investigated through the prototype that is described later, after we summarise the generic design process that produced four Demonstrator applications of knowledge maturing, that is described in more detail in Ravenscroft, Schmidt and Cook (2010).

4.2 Designing in Context: Emphasising Personas, Use Cases and Evolutionary Prototyping

In MATURE a key technique in the design proces is the adoption of Use Cases linked to personas and particular knowledge maturing activities (see Ravenscroft et al., 2009). These personas have been distilled from comprehensive empirical investigations to provide a 'real

human element' through the design process. And the knowledge maturing activities cover processes and practices such as 'Becoming aware of developments and changes' and 'Learning by finding and communicating with people'. So this design methodology emphasises: the reality of, and variation in, 'real people' using the tools; the interaction of users (i.e. actors) with the software system; and, the linking of interactions to predominantly social knowledge maturing processes and activities. Also, this specialised Use Case technique is not dependant on technical details, and is primarily synthetic, in that it is a 'language of design' that all stakeholders can understand and contribute to. Eight initial Design Studies were performed which investigated how candidate technologies could support the key conceptual dimensions of the project. The successful evaluation of this initial design work (Ravenscroft et al., 2009) led to the development of four 'Demonstrators' that emerged from synthesising: the findings from the Design Studies; the most important Use Cases (in both user and knowledge maturing terms); and, how to address key TEL priorities as identified by another European project called PROLEARN.

4.3 Interaction design for contemporary practices

Also fundamental to MATURE is the emphasis on, often creative and open-ended, social and collaborative processes within authentic work-based Communities of Practice (CoP). All of the current Demonstrators, at a high-level, can be conceived as a means to harness or catalyse interactive knowledge maturing processes involving relationships between individuals, social software tools and a work-based learning community. One idea is to identify and externalise embedded and collaborative learning processes, and provide these as practical resources to the work-place community. To demonstrate this, and the other points above, we will now focus on one particular Demonstrator, which synthesises Digital Dialogue Game and Social Bookmarking and Ontology research, to break new ground in digital dialogue and semantic technologies through following the approach of DLD. This line of work has been described in more detail in Ravenscroft, Braun & Nelker (2010).

4.4 A DLD mashup combining dialogue, social bookmarking and collaborative ontologies

The Dialogue Game design concept and InterLoc(v5) have been developed through the MATURE project, to produce a Demonstrator application that supports 'The collaborative development of understanding'. This investigated the role of dialogue as re-usable knowledge, examined semi-natural dialogue as a means to align human and computer semantics, and explored the wider exploitation and adoption of dialogue games more generally.

Note that, initial work in AI and Education that implemented the first educational dialogue games was reported in 1986, this was developed into internet-based CSCL tools realising the games during the early 90s, and now we are elaborating the concept further through the current generation of social software for learning. So we would argue that in this case, as far as dialogue games are concerned, the argument for 'design over technology' is indisputable. The sub-sections below develop and summarise some earlier research reported in Ravenscroft (2008) and Ravenscroft, Braun and Nelker (2010).

Specifically, the prototype supports a community of practice (CoP) in collaboratively developing its understanding of a domain through interweaving the development of a shared information repository and vocabulary (ontology) with dialogues about them. The CoP

collects and bookmarks web resources around their domain and builds up the common multilingual vocabulary (ontology), which is used to organise the web resources 'in action' through annotating them during the bookmarking process. Structured dialogues are used to: discuss and refine the ontology; critically discuss and assess the resources (e.g. reflecting and debating the correctness and quality); and provide a record of dialogue performance that is linked to the related content and are accessible and searchable.

4.4.1 Dialogue as reusable knowledge

The Demonstrator is exploring the re-use of the Collaborative Thinking Texts generated from DDGs, as re-usable knowledge, organised within a collaborative Ontology tool called SOBOLEO (Braun et al, 2007). As mentioned earlier, these capture the thinking of co-interlocutors in a textual form which contains implicit semantic structure that: is a valuable representation of semi-formal argument, in a register between spoken dialogue and written discourse; and, a representation that can be easily searched and semantically processed in argumentative ways. These can support innovative semantic processing, such as searching across dialogues for common disagreements or challenges related to particular topics and how these are addressed, or not, etc. So we could automatically diagnose misunderstandings, conflicts and disagreements within a community, or their representative ontology, to guide further interactions towards resolutions.

4.4.2 Semi-natural dialogue to align human and computer semantics

The latter points are particularly valuable and important in the context of collaborative ontology development, gardening [1] and exploitation. Through the DDGs we can potentially introduce new semantics into ontologies to represent the 'dialogue state' of ontological concepts/resources through semantic tags and awareness provision (e.g. whether a concept has been discussed or not or whether relations are in a state of conflict, etc.). So, in this way there is a continuous connection between resources, ontologies and dialogue processes within the CoP. Aligning and visualising community dialogue and ontology development is potentially powerful. For example, if an ontology concept is not yet discussed or there's a disagreement on features or classification, the system could automatically stimulate a dialogue game to reach consensus or resolve the conflict, etc.

There are several other benefits in 'mashing up' the Social Bookmarking and Ontology and InterLoc tools to investigate learning as knowledge maturing that have been reported in Ravenscroft et al., (2008) and Ravenscroft, Braun & Nelker (2010). Evaluation results have shown the difficulties of easily and directly amending ontologies (Braun et al., 2007a), and so we are proposing a useful and alternative way, through dialogue games, to populate, clarify and refine the ontologies that are produced. Additionally, important dimensions of collaborative ontology development (Braun et al., 2007) such as Appropriateness, Social Agreement and Formality can be negotiated, and therefore also better understood through specially designed knowledge maturing dialogue games. These stimulate users to have a dialogue with, and about, the developing ontologies to specify, clarify and refine the semantic features or degrees of certainty about their classification. This is achieved through specifying the pre-defined Moves and Locution Openers of the dialogue game in terms of the semantic relations and classifications that are implicit in SOBOLEO and supplementing these with attested and more argumentative, or critical, ones from existing dialogue games. This is shown in Figure 3, that demonstrates how the dialogue game approach has been extended to scaffold the ontological classification of resources, related to 'Aqueducts' in this example.

This has been achieved through specifying the pre-defined Moves and Openers of the dialogue game in terms of the key semantic interaction actions within SOBOLEO (e.g. *"Is narrower than", "Is broader than", "Is related to"*) and supplementing these with attested and more argumentative, or critical, ones from existing dialogue games (e.g. *"I think…", "Is it the case that…", "What if…"*).

Figure 3: Resources (about 'Aqueducts') linked to a maturing dialogue game

This approach allows both individual users and the community to have dialogues with and about the ontology, and to construct more understandable and meaningful representations. Allowing the community to engage in collaborative dialogues about the ontologies in this sort of way aims to catalyse and crystallise knowledge maturing and social learning in relation to the domain and the users who are continuously developing their understanding of it. In other words, having a structured dialogue about the development and use of the ontology should actually help to 'bring it to life' and make it more consensual and useful. *This is an exciting and non-trivial exercise, because at a more general level, we are developing the means, through a dialogue game interlingua, to better align human understanding and communication with machine understanding and communication in the context of the semantic web* . This is a big problem, that to our knowledge, no other research is addressing in a way that so directly links authentic users, who are not ontology or even technical experts, with powerful semantic structures that support their behaviour within a CoP.

These functionalities required the extension of SOBOLEO to support the creation, management, and sustainable storage of dialogues - as a searchable resource. Also, we further integrated the possibility to start a maturing game from various points within SOBOLEO as demonstrated in 4, e.g. during the bookmarking and annotating process, when editing the ontology, or when browsing through the ontology and bookmarks.

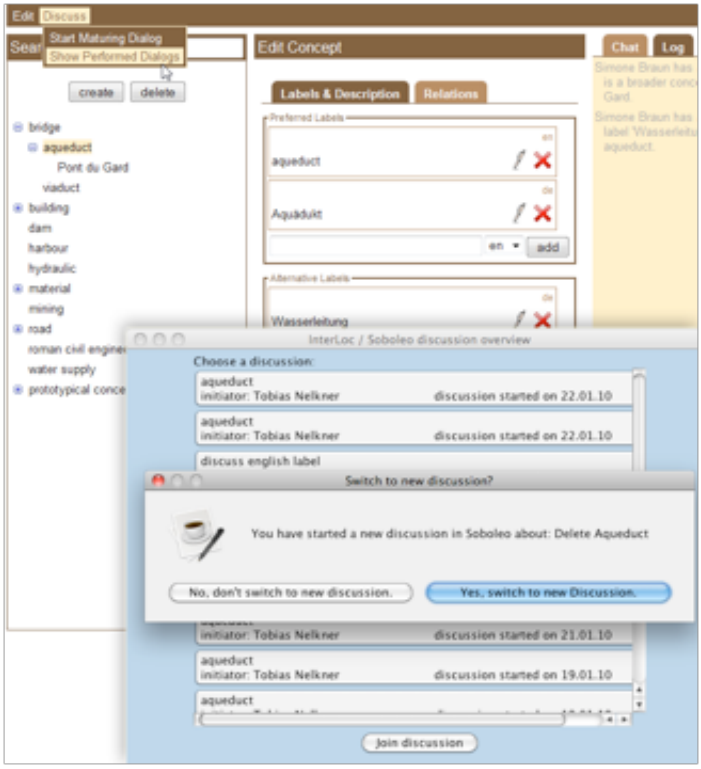

Figure 4: A list of open dialogue games linked to the concepts in the ontology

A WidgetServer (Nelker, 2009), a messaging environment specially developed for easily mashing up and integrating independent software clients , is used to integrate these applications. And so performed dialogues are automatically linked to their related objects. For instance, when navigating to a concept in the browse area, the users can see a list of all performed dialogue games about this concept (Figure 4). The user can have a look at the dialogue's transcript by clicking on one of the listed dialogues. Additionally, it is also possible to continue an existing dialogue game.

When a user (re-)starts a dialogue, a message is sent to all running instances of InterLoc. The user who has started the discussion and all formerly participating users are asked for participation in this dialogue game. For all other users only the list of dialogue games will be refreshed, but they are free to participate.

4.4.3 Formative Evaluation of the SOBOLEO-InterLoc mashup

This mashup for 'The collaborative development of understanding' was introduced and formatively evaluated within a training company (called Structuralia) in 2 phases separated by a period of two months of development which addressed the findings from the first phase. This was a particularly complicated deployment and evaluation because initially the software was in English and had to be translated into Spanish, before being deployed wthin a Spanish context. The distributed 'live' user experience that involved 10 Alumni students (aged between 45 and 55) associated with a vocational course in 'Classic Roman Civil Engineering', ran for approximately one month. The evaluation showed that the mashup and the two incorporated technologies were usable and understandable, but benefitted from significant guidance, animation and input from a facilitator in the company - to contextualise the activities and make them more meaningful. And whilst users understood and used the straightforward functionalities, they did not advance to more sophisticated uses within the limited time period. The dialogue game translation performed well, leading to InterLoc dialogues that were of a reasonable length, well-balanced, coherent and demonstrating

'interthinking' and meaningful collaborative inquiry and critical discussion. Also, some knowledge maturing activity was observable, according to phases 1 and 2 (*Expressing ideas* and *Distributing in communities* respectively) within this short time period (one month) that was implicit in the practice supported by the mashup (of supporting and then storing the dialogue games). Setting these findings against the challenges implicit in this context and the formative nature of the evaluation, we gained some significant insights about the complexity of developing and deploying socio-technical systems within nuanced cultural contexts, that are reported in detail in Ravenscroft et al., (2010b).

5. So what has Deep Learning Design given us?

Through reflecting on the work reported in this article we will now ask what DLD has given us, through considering the completed DDG initiative and the ongoing MATURE project. We argue that this holistic approach to learning design makes improvements or advances on various levels in the DDG case. Firstly, we have developed a successful and sustainable framework for realising reasoned learning dialogue that is still being taken forward and adapted to contemporary learning problems and technical contexts. Secondly, we have made significant advances to the theory of TEL pedagogies (based on notions if *dialogic* and *dialectic*). Thirdly, we have advanced principles for TEL interaction design (of *ambient pedagogy* and *experience design*) that are particularly relevant to the social software and web 2.0 landscape. Or, In brief, this DDG initiative has over the past 10 years, advanced: academic discourse in digital dialogue; provided innovative digital tools; and, had practical impact on pedagogies for TEL.

In terms of the MATURE project, the DLD approach, as a variation of DBR, has contributed the following. Firstly, it has provided an overarching framework that helps to understand, organise and synchronise a complex multi-partner project. This is neatly captured in Ravenscroft Schmidt and Cook (2010), which explains the successful execution of the approach and how it links user-centric design methods with an evaluation framework capturing the synthesis of the conceptual, technical and end-user perspectives. Secondly, it has facilitated the deployment and extensive formative evaluation (see Ravenscroft, et al., 2010b) of four Demonstrator prototypes in authentic work-based settings within a timeframe that allows necessary refinements to the technical developments and the negotiation of nuanced user-system-context scenarios. Thirdly, the emphasis on 'design, interaction and evaluation in context', within the relatively early stages of a four year project, has led to many useful insights. These have been about the usability and suitability of the particular Demonstrator applications and the complexity of developing socio-technical systems within work-based contexts and cultures. With regard to the latter, we have clearly recognised and problematised the necessary system-context 'fits', or methods for negotiating such 'fits', that are required to realise knowledge maturing.

5.1 What is missing from DLD?

This approach of Deep Learning Design is motivated by the challenge of designing learning in the Web 2.0 landscape whilst avoiding technological determinism. Considering these means that inevitably other key dimensions will need to be considered, that are also emerging as important. Two of these are the role of emotion - and related issues of motivation, and multimodal literacies. Technology is no longer something that we just use to perform tasks, but is now part of our emotional landscape, in terms of how we relate to it, or relate to others through it. Emotion is possibly the most neglected human dimension that we

now need to embrace if we want to design truly engaging learning. Similarly, changes in literacy and the semiotic substrate of our communications are profound, so we need to re-think our learning design and practices based on the current and likely future semiotic landscapes. We are only just beginning to sketch out and understand what these might be. For example, is text dead? And instead, will our learned communications become multimodal narratives, where future dialogues are more like collaborative films than oral or written text. And if so, how would that affect, for example, Vygotskyan approaches and frameworks?

6. Conclusions

This article has made the case for the original approach of Deep Learning Design, through demonstrating its applicability and power from research into 'dialogue games' that began over ten years ago to an ongoing flagship project in 'continuous social learning in the work-place'. Perhaps the key argument is, given that the pace of change of technology is unlikely to slow down, 'design' is a more powerful, flexible and future-proof notion than technical functionality. Nevertheless, this concept needs to be articulated in contexts where digitally mediated communication, in many forms, changes internal and external representations of knowledge in ways, means, and at speeds, that we have never before experienced. The projects referred to in this article address this challenge, and in certain ways, use designs to make the complex simple to realise well attested approaches to dialogue, reason and understanding. Foregrounded within this creation and development of meaning, is the relationship between deep learning design and context. Deep learning design is, ostensibly, an approach for producing enhanced contexts for learning.

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[1] 'gardening' is a technical term used by the Ontology community to refer to how ontologies are revised and maintained.