

Cite as: Ravenscroft, A. & Boyle, T. (2010). Deep Learning Design for Technology Enhanced Learning, Full Paper Accepted for *International Conference on Educational Media (Ed-Media) 2010*, Toronto, June 29-July 2 2010.

Deep Learning Design for Technology Enhanced Learning

Andrew Ravenscroft & Tom Boyle

Learning Technology Research Institute (LTRI)
London Metropolitan University, UK.
<http://www.londonmet.ac.uk/ltri/>
a.ravenscroft@londonmet.ac.uk
t.boyle@londonmet.ac.uk

Abstract: To address the salient challenge of designing Technology Enhanced Learning (TEL) amidst wide-ranging and profound technological changes, within Web 2.0 landscape and beyond, we are developing the 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 learning design; explain why the challenges raised necessitate the introduction of this new approach to design; and, exemplify and map this new notion of design to two large-scale Design Based Research (DBR) initiatives. These are projects in Digital Dialogue Games (DDGs) and Reusable Learning Objects. Finally some implications are considered and some conclusions are drawn.

Keywords: learning design, technology enhanced learning, contemporary pedagogy

1. Introduction: Why deep learning design (DLD)?

Changes in underpinning learning technologies, or implicated ICTs in general, occur at a pace we have never before experienced, and it is unlikely to slow down. This necessitates a broader and more profound understanding of design for Technology Enhanced Learning (hereafter TEL), that is more future-proof than relying on the latest or emerging technologies and yet embraces the multimodal, collaborative and ubiquitous nature of learning in 21C. This implies that we need an approach to learning design that is in harmony with the digitally literate teacher and learner in the Web 2.0 age and beyond, and, also recognises stable standards and practices of successful existing pedagogy. This means that we need to, through design, reconfigure attested pedagogy rather than supplant it (Ravenscroft, 2009).

In addressing this difficult but important challenge this paper will present and develop the approach of Deep Learning Design (hereafter DLD), and articulate it through two substantial large-scale research and development initiatives in dialogue-rich learning and reusable learning objects. Note that due to space restrictions we will deliberately avoid a focus on 'learning design' (with a small 'l' and 'd') and 'Learning Design (LD)'. These typically refer to practical and technology inspired approaches to pedagogical modelling and sharing teaching practice (e.g. Lockyear et al., 2009; Laurillard, 2008; Brittan, 2004), where LD (e.g. Koper & Miao, 2009) is a particular branch of this based around the IMS-LD standard. So, these approaches are typically an alias for contemporary approaches to technology inspired instructional or curriculum design. In contrast DLD is a research driven paradigm for designing contemporary learning that adopts a more humanistic and holistic stance that incorporates an emphasis on teachers' and learners' active processes and practices within contexts. Therefore this framework, or approach, makes use of a combination of Design Based Research (see Design Based Research Collective, 2002; Sandoval & Bell, 2004) and Action Research methodologies that allow us to fully articulate a picture of: designs linked to theories, 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. Key principles of DLD

The following key principles, adapted from Ravenscroft (2009), define DLD.

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 informed by learning theory or pedagogical frameworks, and without this, they aren't TEL designs. Instead they are simply interaction designs. Secondly, and perhaps most obviously, good theories have powerful potential to guide design, and therefore instantiating these 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 decide what is important in evaluations.

2.2 Design as the key development concept

Given the pace of change of the technological possibilities that support learning, we argue, that 'design' is a suitably rich, flexible and yet formal enough concept 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. It is interesting and important to note that, for each technological wave (e.g. Artificial Intelligence and Education, Hypertext, Computer Supported Collaborative Learning), 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.

2.3 Development and Interaction in context

DLD recognises that we need to perform development and devise interaction designs within social and culturally coordinated contexts. And these designs should ideally incorporate an articulation of learning that links cognition, communication and context (Ravenscroft, 2004). This means that we need to link notions of cognitive change, in terms of improved knowledge or reasoning, to competencies that lead to tangible practices in contexts, where improvements that correspond to learning are measurable through evaluations. For example, as illustrated in Section 3, linking Vygotskian notions of internalisation to identifiable changes, such as improvements in understanding a topic or general improvements in critical thinking that occurred in authentic educational contexts.

A corollary of these points above is that in contemporary learning contexts TEL design needs to emphasise: the relevance and richness of the teachers' and learners' experience within contexts (and not just pedagogical procedures); rich interaction and social processes that are mediated by technologies (and not necessarily dictated by them); an emphasis on participative and responsive communication; and, the increasing prevalence of digitally-mediated learning practices being 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/or the expectations or problems within the contexts of use. In contemporary learning situations, 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, and may also follow Action Research or more conventional empirical approaches. 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 they do 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 Exemplar projects

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 the production and use of pedagogy rich reusable learning objects on a huge scale, are described below. The Digital Dialogue Game (hereafter DDG) initiative is a multi-partner initiative that has been supported by various projects over the past decade (see Ravenscroft 2007 for a review, and www.intreloc.org), and the RLO CETL (Centre for Excellence in Teaching and Learning in Reusable Learning Objects) is a large scale collaborative project (involving London Metropolitan, Cambridge and Nottingham Universities in the UK) that has been conducted for the past four years (see www.rlo-cetl.ac.uk).

3. A digital dialogue and social software perspective

In conceptualising TEL interaction design as DLD, one particular perspective we introduce here appreciates and articulates the 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). Although the form and means of realisation of 'learning dialogue' is 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 DDGs and InterLoc. So in this Section we map the DDG initiative to the principles of DLD.

3.1. Theoretical and conceptual foundations

Theoretically, the DDG approach is driven by Vygotskian (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). 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 explicit pedagogical design.

3.2. The design level

The DDGs are by their nature a flexible design paradigm that has 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). Central to this is a methodology, of 'investigation by design' (hereafter IBD) that is technology neutral, in that it formulates models that are formal enough to be implemented, yet without predicating a particular technology for implementation.

The latest tools (e.g. InterLoc5) have been produced through a refinement of the IBD methodology. This has involved introducing 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 give a concise demonstration of how this project operationalised the principles of DLD. It provides a snapshot that shows how a TEL tool links theory-driven interaction design to an authentic context of use, which has also undergone thorough evaluation. This tool is described in detail in Ravenscroft, McAlister and Sagar (2009) and Ravenscroft et al., (2008) and is summarised below for the purposes of this paper.

The key features of the DDGs 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 Assertions openers);
4. Dialogue Game as both a conversation and re-usable resource, known as a Collaborative Thinking Text (CTT).

As these features have been described in detail elsewhere, I will now focus on demonstrating how the design operates in linking social and cognitive dimensions of learning in the context of an authentic digital practice, in a learning activity that is configured by the tutor but performed by the learners. This involved PGCE Science students from a UK University playing a critical discussion and reasoning game (CDR-DG) to further their collective understanding of, and questioning the UK national curriculum for Science. This activity is discussed in more detail in Ravenscroft et al., (2008), and Ravenscroft McAlister and Sagar (2009).

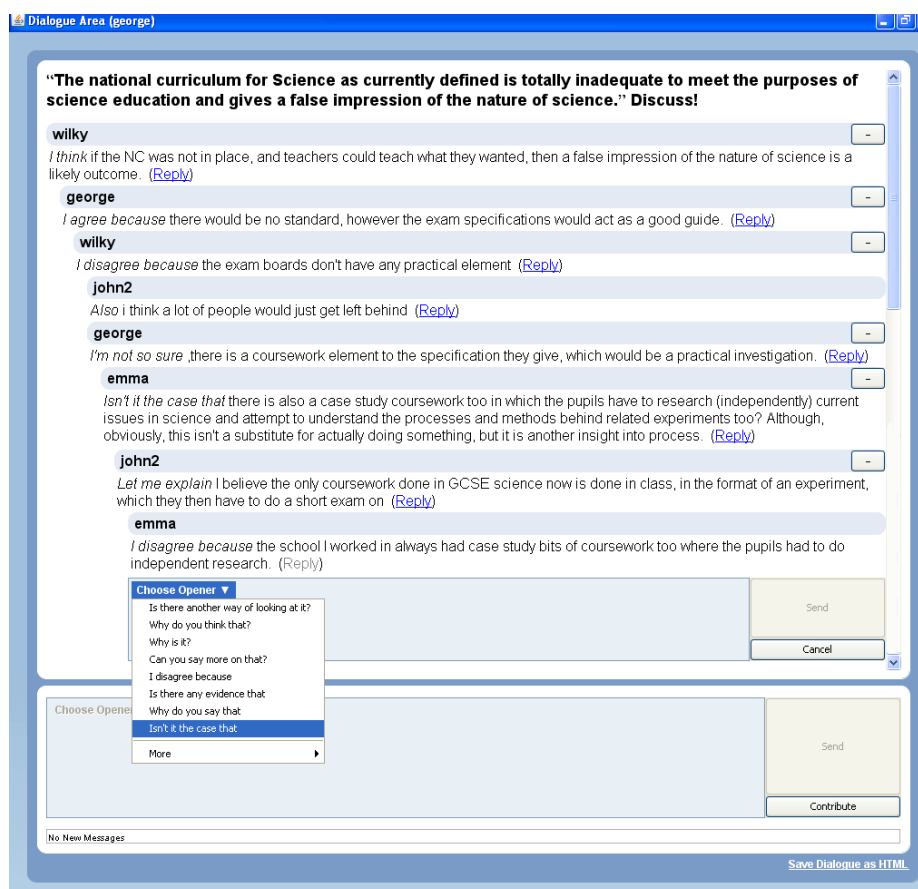


Figure 1: InterLoc(v5) Screenshot demonstrating the Critical Discussion and Reasoning (CDR) game

The interface in Figure 1 shows how each player performs the dialogue game. 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). All contributions or replies are made using the pre-defined Move categories (Inform, Question, Challenge etc.) and the specific locution openers (“*I think...*”, “*I disagree because...*”, “*Let me elaborate...*” etc.) that have to be used to perform the dialogue. Similarly, rules about the legitimate and logical responding openers, based on the specific Openers that are replied to, are offered selectively. So in this example (in Figure 1) the responding player (George) is presented with logically legitimate responses to “*I disagree because...*”, such as “*Is there another way of looking at it?*”, “*Why do you think that?*” etc.. Although they are not restricted to this preferred response set, and can instead select “More” to see the full range of Openers. So a structured and yet flexible form of scaffolding is provided.

The player interface (Figure 1) shows how the adoption of 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. Similarly, it supports a style of interaction that builds on students’ experiences with other familiar technologies like MSN and Skype. Also, a model of turn-taking is incorporated to promote logically coherent, rather than sequentially incoherent, dialogue, and also ‘listening’ to others contributions. In this brief interchange (of a sequence of coherent replies) we can still see how InterLoc supported reasoned agreement, reasoned disagreement and then the further elaboration and clarification of concepts (related to the role of practical work in the National Curriculum).

3.3. Development and interaction within authentic and meaningful contexts

The example above demonstrates how the DDGs and InterLoc embody the need to reconcile learners developing digital literacies with the well-established requirements for reasoned and purposeful dialogue. Specifically, through incorporating the notions of ‘ambient pedagogy’ and ‘experience design’, we have provided a managed and yet attractive and inclusive learning context and experience through realising a structured, collaborative and engaging learning practice. The design was developed through evolutionary prototyping that incorporated a user-intensive and participatory Action Research approach. The resulting technology and practice allows tutors or learners to incorporate any social media (accessible via a URL) and link these to the dialogue games. This in turn, generates collaborative and personalised texts or knowledge assets. So this practice can easily link learners’ interest-driven, and typically media-centric behaviours, to more learning-driven dialogue and textual practices. The outcomes of this design are personal, such as the development of understanding and internalisation of dialogue and knowledge skills, and collaborative, such as the production of a shared and tangible Collaborative Thinking Text (CTT). So the players don’t just gain more knowledge, but are able to reason and think in context (e.g. like a scientist). Here the role of the teacher is also important, as although they are no longer being didactic, they typically: legitimise and set up the activity through selecting appropriate materials and a suitable dialogue game; and, ground the activity as a collaborative project anchored within the curriculum, so the students aren’t just ‘doing’ a disconnected dialogue game activity. 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. *This rendering of a validated pedagogical framework (e.g. Ravenscroft & Matheson, 2002) and similarly validated learning design (e.g. Ravenscroft & McAlister, 2008) into a tutoring practice and digital learning experience (see Figure 1) that is relevant and familiar to users, and which is subsequently evaluated (see below), is the essence of deep learning design.*

3.4. 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 Ravenscroft (2009). Summarising these latest findings, they showed that InterLoc: was easy and intuitive to use; was popular with, and valued by, tutors and students; and most importantly, succeeded in providing a unique way to stimulate critical and collaborative thinking amongst students – as evidenced through student and tutor appraisals, and analysis of the dialogues. The generated content, or Collaborative Thinking Texts, were used in varied and sometimes unanticipated ways by students and tutors.

4. A learning objects and reusable learning design perspective

This second exemplar case of DLD focuses on rich interaction with multimedia learning objects. The traditional standards-based approach to learning objects has focused on content and standards for packaging and describing this content (e.g. IMS 2009, IEEE 2002, ADL SCORM 2009). Boyle (2008) has argued that we need to tackle the central issue of the design and development of high quality learning objects in the first place:

“high quality design and development of learning objects is crucial before we get to issues of metadata and software packaging. The primary message ... is good pedagogical design is at the heart of effective learning objects (Boyle 2008)”.

This initiative was started to address significant problems with learning computer programming, where the learning objects were conceived as micro-contexts that scaffolded learning, and their success in this respect was striking (Boyle et al 2003). Since then, the approach has been scaled-up considerably to provide methodologies and tools (such as the GLO-Maker authoring tool) for producing similarly conceived learning objects on a large scale.

4.1 Theoretical and conceptual foundations

The theoretical base for the learning objects is based on the constructivist ideas of Piaget and Bruner (1964) and in particular Bruner’s notion of *ratiocinative amplifiers* (Flavell 1996, Bruner 1964). These have been resolved into a series of design principles for developing reusable learning objects (Boyle 2003).

A major evolution in these design ideas led to the concept of Generative learning objects (GLOs). GLOs rely on design rather than content as the basis for reuse. This requires a theoretical base for generating learning objects based on underlying pedagogical designs. This theoretical base was supplied by generative linguistics, in particular, Systemic Grammar. Generative linguistics distinguishes between the deep structure and surface structure of language. In Systemic Grammar deep structure is represented as the *functions* which language serves. These functions are mapped onto the surface *forms* of syntax. This framework of the deep structure and pedagogical functions being mapped to surface structure and form provides the basis for the generative learning objects approach. The deep structure of a design is captured as the decisions that the tutor makes about the *functions* that the learning object should serve. These are captured in the Planner section of the GLO Maker authoring tool (Figure 2). These functions are then mapped onto surface forms – screen layouts, which realise these functions (Figure 3). These screen layouts provide flexible templates for the insertion of media content such as text, pictures and videos. The process of developing a GLO thus involves making deep functional decisions, which are mapped to default ‘surface structure’ of screen layouts, to which the individual media content is added. The conceptual approach is essentially generative. This distinguishes it from approaches to describing the learning design that are essentially descriptive in approach (e.g. IMS LD 2003).

4.2 Design as the key development concept

The concept of ‘generative learning objects’ focuses on design as the basis for reuse. This approach arose out of the work of the Centre for Excellence in Teaching and Learning in Reusable Learning Objects. This centre has developed and evaluated around 200 rich multimedia learning objects and

these are all available from the CETL website (<http://www.rlo-cetl.ac.uk>). The work on developing these learning objects highlighted three issues: that design is the central focus for pedagogical reuse (not just content); productivity needs to be supported; and easy adaptability needed to be possible.

4.3 Development and interaction in context

The multimedia learning objects were normally developed by a team involving at least one tutor and multimedia developer (and usually one or more students - Boyle et al 2006). However, this was an intensive process which was difficult to scale up. So the challenge was to find a way of enabling tutors to develop multimedia learning objects. It was clear that these learning objects needed to be adaptable as local tutors often wanted to alter them to meet their needs and preferences. The key to resolving these issues was the third factor. These learning objects were developed to solve pedagogical problems and often involved interesting pedagogical designs. The generative learning object approach takes these designs as the basic unit from use. These are incorporated in the GLO Maker tool that enables tutors to use in-built designs to create new specific learning objects. Any learning objects so created can be altered and adapted using the same tool. This authoring tool is open source and can be downloaded for free: (<http://www.glomaker.org>).

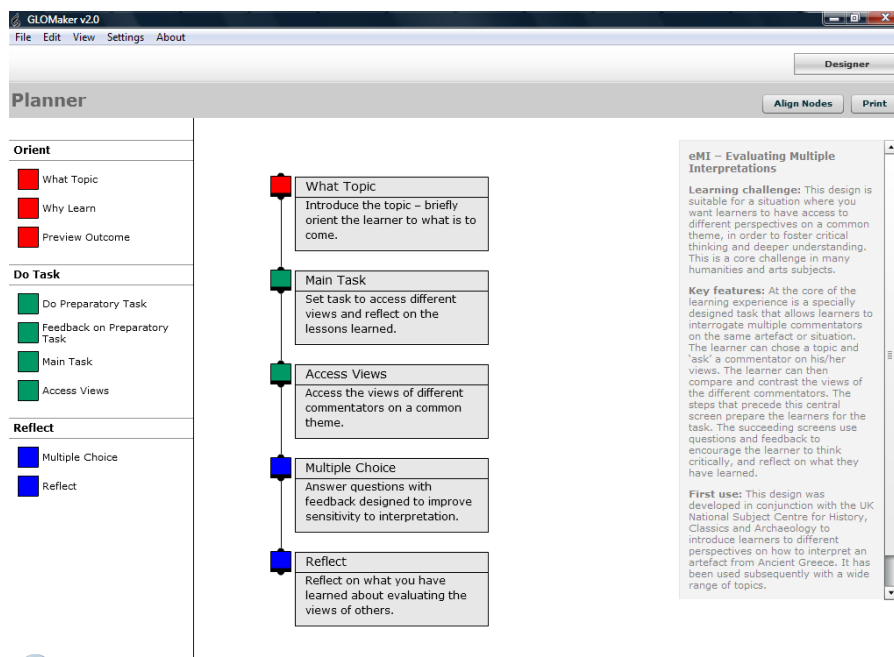


Figure 2: A pedagogical plan in GLO Maker

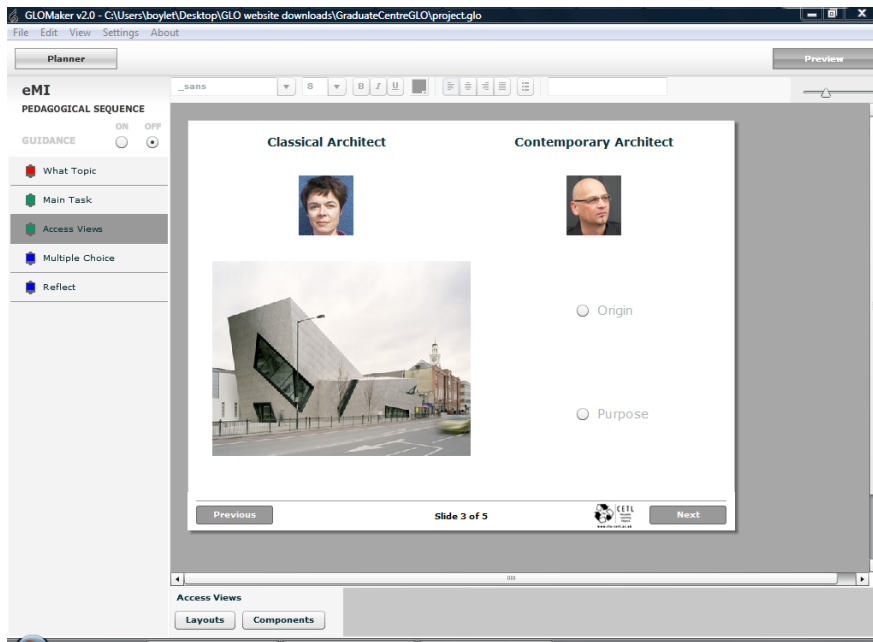


Figure 3: Surface structure realization of the plan in GLO Maker (with content inserted). The function “Access Views” has been mapped to the default screen layout shown

If design is the central concept then we need a development process that encourages and facilitates good design linked to authentic contexts of use. The RLO-CETL has developed an Agile approach to the design and development of learning objects (Boyle et al 2006). This approach may be used to create one-off learning objects, or reusable designs that provide the basis for creating many learning objects. This Agile approach involves tutors, and usually students, working in groups to collaboratively design solutions in their teaching-learning contexts. Formative evaluation is thus built in at all stages in the design and development process. The development process moves from initial brainstorming and sketching of ideas, through to eventually capturing these in a form that can be represented in the GLO Maker tool.

4.4 Evaluation approach

Each new batch of learning objects is normally subjected to prolonged use and evaluation with students. The learning objects are incorporated as part of the students' normal course, and field evaluation data is collected on the students' use and views of the learning objects. The students will normally use the learning objects over a period of weeks. This period may range from one week to a full term/semester.

The evaluation is concerned with the extent and pattern of the students' use of the learning objects, their assessment of the learning objects, and evidence for the pedagogical effectiveness of the learning objects. The evaluation regime may use one or more of the following techniques: online tracking of the students use of the learning objects; direct observation of the use of the objects, for example, in laboratory sessions; questionnaires to elicit the views of the full student cohort; detailed qualitative student feedback through interviews and/or focus groups; and, measures of improved student performance in, for example, class tests (Bradley & Boyle 2004).

The evaluation data for each batch of learning objects are incorporated in a report to the Local Academic Co-ordinators, and through them to the CETL Management Committee. By the end of this phase the learning objects are ready for packaging and storage in the main CETL learning object repository; this is open for external searching, downloading and reuse of the learning objects.

5. Discussion and implications

Implicit in our argument for deep learning design is the need to rethink pedagogy in ways that reconcile the wide-ranging changes in digital literacies and accepted standards, roles and practices within education. Or, putting this another way, in developing contemporary pedagogies we need to be

thoughtful in the ways we employ designs, that should contain a judgement about what is changing and what should be staying the same. Making such judgements is easier when we introduce a TEL innovation to address a problem or provide a clearly justified opportunity, or as Draper (1998) pointed out, their needs to be a niche for there to be success in the adoption of an emerging or advanced learning technology. Both lines of work described in this paper were stimulated by the need to address a severe learning problem, namely: the need to support critical discussion and engagement between learners who could not be co-present; and, the need to support the learning of programming in ways that addressed severe drop-out rates amongst students. And since then, both initiatives have developed in ways that have been responsive to emergent problems.

Unfortunately, performing the reconfiguration of pedagogy in these sorts of ways is sophisticated and can be unpopular in situations where there is often a political agenda for technology to make education easier, cheaper and more accessible to all. But the canon of work in Intelligent tutoring systems (e.g. Wenger, 1987) and recent work in Virtual Learning Environments has shown that you can't learn by just being taught. And similarly, recent attempts to exploit social software for learning (e.g. Ravenscroft, 2009; Hatzapanagos & Warburton, 2009) have shown that you can't learn by simply being given personalised opportunities for it. This is precisely why we need Deep Learning Design, to orchestrate learning within new technology-mediated pedagogical frameworks. Perhaps one notable shift here, as Preece (2009) alludes to, is that the teacher should enter and configure the learner's digital world, instead of expecting the students to enter theirs. This brings us to the notion of context, which is often oversimplified in the literature. As we argue that it is not whether the context is tutor oriented, institutional and pre-defined or student-oriented, open and generated that is most important, but whether what is created is a 'learning context'. The example projects in this article have clearly been successful in creating learning contexts with varying degrees of tutor and student control (e.g. see Ravenscroft et al. 2009; Holley et al., 2007) and continued on relatively large-scales for long periods of time. And what is interesting about both is that they have configured or supported new and creative contexts for learning that contain a modified, but: clear role for the tutor; clear role for the learner; and, a clear role for the technology.

Continuing with this stance of retaining the key roles within the educative system but reconfiguring them in line with emerging digital practices should help us to make better predictions about successful future learning. Few people would argue against it being inevitable that future learning practices will be more personalised, ubiquitous, collaborative and creation-oriented, but the way we represent the changing roles of the teacher and learner, or who exactly is the teacher and the learner, are more contested. One way this can be reconciled in terms of future learning contexts is to introduce the notion of who has 'initiative' in a context at any moment in time, rather than differentiating whether these are tutor-generated or learner-generated. In the examples in this paper we can see that the tutor initially takes the initiative to set up a context, but then the learners take the initiative to realise the learning processes, with interactive technologies and other learners. So, tutor, technology and students all participate in and co-create the learning context.

6. Conclusions

This article has presented and developed the approach of Deep Learning Design, which aims to embrace the new possibilities provided by our digitally enriched landscape whilst avoiding the sort of technological determinism that is unhealthy for learning. The included projects that are exemplars of this approach have been successful and longstanding because they: address clear problems; have strong theoretical and conceptual underpinnings; and, provide substantial empirical verification. Or, in brief, they have 'squared the circle' by focussing on design as the central construct and not introduced favoured technologies in search of an application. Instead they have matched technologies to problems and then refined their approach in light of evaluations. We argue that this process will always be the case, with no or very few 'off the shelf' TEL solutions, because our learning problems and solutions in the Web 2.0 landscape and beyond will always be co-evolving.

7. References

ADL SCORM (2009) <http://www.adlnet.gov/Scorm/>

Bakhtin, M. (1986). *Speech genres and other late essays*. Austin: University of Texas.

- Bradley C. and Boyle T. (2004) The design, development and use of multimedia learning objects. *Journal of Educational Multimedia and Hypermedia, Special Edition on Learning Objects*, 13, 4, 371-389.
- Boyle, T. (2003). Design principles for authoring dynamic, reusable learning objects. *Australian Journal of Educational Technology*, 19, 1, 46-58. : <http://www.ascilite.org.au/ajet/ajet19/boyle.html>
- Boyle T., Bradley C., Chalk P., Jones R. and Pickard P. (2003) Using blended learning to improve student success rates in learning to program. *Journal of Educational Media, Special Edition on Blended Learning*, 28, 2&3, 165-178.
- Boyle, T. (2003). Design principles for authoring dynamic, reusable learning objects. *Australian Journal of Educational Technology*, 19, 1, 46-58
- Boyle T. (2008) The design of learning objects for pedagogical impact. In Lockyer, I., Bennett, S. Agostinho S. and Harper B. (Eds) *The Handbook of Research on Learning Design and Learning Objects: issues, applications and technologies*. Information Science Reference.
- Boyle T, Windle R., Leeder, D., Wharrad H., Alton, R and Cook J. (2006) An Agile method for developing learning objects. *Proceedings of the 23rd annual Ascilite conference: Who's learning? Whose technology?* Available online at: http://www.ascilite.org.au/conferences/sydney06/proceeding/pdf_papers/p64.pdf
- Brittan, S. (2004). A review of learning design: Concepts, specifications and Tools. A report for the JISC e-learning and pedagogy programme, Bristol, UK.
- Bruner, Jerome S. (1964) The course of cognitive growth. *American Psychologist*, Vol 19(1), 1-15.
- Flavell, J. H. (1996) Piaget's Legacy. *Psychological Science*, 7(4), 200-203
- Design-based research collective (2002). Design-Based Research: An Emerging Paradigm for Educational Inquiry, *Educational Researcher*, Vol 32, No. 1, pp5-8.
- Draper, S. (1998). Nice-based success in CAL. *Computers and Education 1998 vol.30, pp.5-8*
- Hatzipanagos, S. & Warburton, S. (2009), (Eds.), *Social Software & Developing Community Ontologies*, IGI Global Publishing
- Holley, D, Cook, J, Bradley, C, Haynes, R and Smith, C. (2007). Getting Ahead at University: Using Reusable Learning Objects to Enhance Study Skills, Full paper presented at ED-MEDIA 2007 - World Conference on Educational Multimedia and Hypermedia, June 25-29, Vancouver, Canada
- Koper, R., & Miao, Y. (2009). Using IMS-LD Standard to Describe Learning, in Lockyear, L., Bennet, A., Agostinho, S. & Harper, B. (Eds), *Learning Design and Learning Objects*, Vol. II, Information Science, Hershey, New York, pp 41-86.
- Levin, L.A. & Moore, J.A. (1977). Dialogue-Games: Metacommunication Structures for Natural Language Interaction. *Cognitive Science*, 1, (4), 395-420.
- Mackenzie, J. D. (1979). Question-begging in non-cumulative systems. *Journal of Philosophical Logic*, 8, 117-133.
- Laurillard, D. (2008). The teacher as action researcher: using technology to capture pedagogic form. *Studies in Higher Education*, 33(2), 139-154.
- Mercer, N. (2000) *Words and Minds: how we use language to think together*. London: Routledge
- Pilkington, R.M. (1999). *Analysing Educational Discourse: The DISCOUNT Scheme*. Version 3, January 1999. CBL Technical Report No. 99/2

- Preece, J. (2009), Forward, in Hatzipanagos, S. & Warburton, S. (2009), (Eds.), *Social Software & Developing Community Ontologies*, IGI Global Publishing
- Ravenscroft, A. (2004). Towards highly communicative eLearning communities: Developing a socio-cultural framework for cognitive change. In Land, R & Bayne, S. (Eds.) *Cyberspace Education*. Routledge, Chapter 9, pp 130-145
- Ravenscroft, A. (2007). [Promoting Thinking and Conceptual Change with Digital Dialogue Games](#), *Journal of Computer Assisted Learning (JCAL)*, Vol. 23, No 6, pp 453-465
- Ravenscroft, A. (2009). Social Software, Web 2.0 and Learning: Status and implications of an evolving paradigm, Guest Editorial for Special Issue of *Journal of Computer Assisted Learning (JCAL)*, Vol 21, Issue 1, 2009, pp 1-5
- Ravenscroft, A. (2009). Deep Learning Design for Technology Enhanced Learning: A Dialogue and Social Software Perspective, *Journal of Interactive Media in Education*, Invited for UK Open University (OU) Computers and Learning Research Group (CAL-RG) 25th Anniversary Special Issue. (Submitted)
- Ravenscroft, A. & Cook, J. (2007). New Horizons in Learning Design, Chapter 16 in *Rethinking pedagogy for the digital age: Designing and delivering e-learning*, Beetham, H & Sharpe, R. (Eds), Routledge, pp 207-218
- Ravenscroft, A. & Matheson, M.P. (2002). Developing and evaluating dialogue games for collaborative e-learning interaction, *Journal of Computer Assisted Learning: Special Issue: Context, collaboration, computers and learning*, Vol. 18, No. 1, pp. 93-102
- Ravenscroft, A. & McAlister, S. (2006). Digital Games and Learning in Cyberspace: A Dialogical Approach, *E-Learning Journal*, Special Issue of Ideas in Cyberspace 2005 Symposium, Vol. 3, No 1. pp 38-51 (In Press). Available online from: http://www.wvwords.co.uk/elea/content/pdfs/3/issue3_1.asp#5
- Ravenscroft, A. & McAlister, S. (2008). Investigating and promoting educational argumentation: towards new digital practices, *International Journal of Research and Method in Education (IJRME)*, Edited by Caroline Coffin and Kieran O'Halloran, Vol. 31, No. 3, pp 317-335
- Ravenscroft, A. & McAlister, S. & Sagar, M. (2009). Digital Dialogue Games and InterLoc: Deep Learning Design for Collaborative Argumentation on the Web, Book Chapter in Pinkwart, N. "Educational Technologies for Teaching Argumentation Skills", Bentham Science E-Books. (In Press)
- Ravenscroft, A. & Pilkington, R.M. (2000). Investigation by Design: Developing Dialogue Models to Support Reasoning and Conceptual Change, *International Journal of Artificial Intelligence in Education*, Vol. 11, Part 1, pp. 273-298
- Ravenscroft, A., Sagar, M., Baur, E & Oriogun, P (2009). [Ambient pedagogies, meaningful learning and social software](#). Hatzipanagos, S. & Warburton, S. (2009), (Eds.), *Social Software & Developing Community Ontologies*, IGI Global Publishing, pp 432-450
- Ravenscroft, A., Wegerif, R.B. & Hartley, J.R. (2007). [Reclaiming thinking: dialectic, dialogic and learning in the digital age](#), *British Journal of Educational Psychology Monograph Series, Learning through Digital Technologies*, Underwood., J & Dockrell, J. (Guest Eds), Series II, Issue 5, pp 39-57
- Searle, J. (1969). Searle, J. R. (1969). *Speech Acts: An essay in the philosophy of language*, Cambridge University Press.
- Sandoval, W. A., & Bell, P. L. (2004). Design-based research methods for studying learning in context: Introduction. *Educational Psychologist*, 39(4), 199–201.
- Vygotsky, L. (1978). *Mind and society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press

Walton, D. N. (1984). *Logical Dialogue Games and Fallacies*. Lanham: University Press of America.

Wenger, E. (1987). *Artificial Intelligence and Tutoring Systems: Computational and Cognitive Approaches to the Communication of Knowledge*, Morgan Kaufmann Publishers.

Wegerif, R.B. (2007). *Dialogic, Education and Technology: Expanding the Space of Learning*. New York: Springer-Verlag