TECHNOLOGY ENHANCED LEARNING

The Art & Science of Learning Design

Marcelo Maina, Brock Craft and Yishay Mor (Eds.)

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The Art & Science of Learning Design

TECHNOLOGY ENHANCED LEARNING
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Scope

The rapid co-evolution of technology and learning is offering new ways to represent knowledge, new educational practices, and new global communities of learners. Yet the contribution of these changes to formal education is largely unexplored, along with possibilities for deepening our understanding of what and how to learn. Similarly, the convergence of personal technologies offers new opportunities for informal, conversational and situated learning. But this is widening the gulf between everyday learning and formal education, which is struggling to adapt pedagogies and curricula that were established in a pre-digital age.

This series, *Technology Enhanced Learning*, will explore learning futures that incorporate digital technologies in innovative and transformative ways. It will elaborate issues including the design of learning experiences that connect formal and informal contexts; the evolution of learning and technology; new social and cultural contexts for learning with technology; novel questions of design, computational expression, collaboration and intelligence; social exclusion and inclusion in an age of personal and mobile technology; and attempts to broaden practical and theoretical perspectives on cognition, community and epistemology.

The series will be of interest to researchers and students in education and computing, to educational policy makers, and to the general public with an interest in the future of learning with technology.

The Art & Science of Learning Design

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TABLE OF CONTENTS

PREFACE

The Art and Science of Learning Design (ASLD) workshop[1] was convened in October 2011 in London, UK, to explore the tools, methods, and frameworks available for practitioners and researchers interested in designing for learning, and to articulate the challenges in this emerging domain. The workshop adopted an unconventional design, whereby contributions were shared online beforehand, and the event itself was dedicated to synergy and synthesis. In a novel bid to make the workshop as open as possible, to external as well as on-site participants, social media tools were employed to support dissemination contemporaneously with the events at the workshop. Participants were encouraged to write collaboratively and critique online, to use twitter, and to contribute to workshop sessions in cloudWorks,[2] a social networking site for finding, sharing and discussing learning and teaching ideas and designs.

The present volume is based on the outcomes of the ASLD workshop and the debates that followed since, including the special issue of Research in Learning Technology (Mor & Craft, 2012; Mor, Craft, & Hernández-Leo, 2013), and is organised according to some of the thematic strands that were used to structure it. In this introductory chapter, we present the field of Learning Design[3] and the topical themes of the workshop. We begin by presenting and comparing the common definitions of Learning Design (LD), and clarifying its links to the related but distinct field of Instructional Design (ID). We then relate conceptions of Learning Design to the structure of the book. We explore its relevance and value to the stakeholders of Learning Design by highlighting some of its current issues and challenges. We conclude with an overview of the chapters in this book, relating them to these key thematic strands of Learning Design and its grand challenges.

NOTES

1. http://www.ld-grid.org/workshops/ASLD11
2. Topics on Cloudworks are organised as "clouds" and "cloudscapes". The ASLD workshop clouds, comprising comments, discussions, notes and the accepted peer-reviewed papers can be found within the ASLD cloudscape: http://cloudworks.ac.uk/cloudscape/view/2349
3. We use Learning Design (capitalised) to refer to the field, and learning design to refer to the act of designing for learning or its outputs.

YISHAY MOR, BROCK CRAFT AND MARCELO MAINA

INTRODUCTION

Learning Design: Definitions, Current Issues and Grand Challenges

BACKGROUND

We live in an era defined by a wealth of open and readily available information, and the accelerated evolution of social, mobile and creative technologies. The provision of knowledge, once a primary role of educators, is now devolved to an immense web of free and readily accessible sources. Consequently, educators need to redefine their role not just “from sage on the stage to guide on the side” (King, 1993) but, as more and more voices insist, as “designers for learning” (Goodyear & Dimitriadis, 2013). Adopting a designer mindset means using empathy and observation to understand where the learners are, and creating the things that will help them get to where you want them to be, be those tasks, resources, social configurations or tools. These are exciting times for educators, but they also entail increasingly complex challenges. Educators may still provide access to information, yet now they also need to carefully craft the conditions for learners to enquire, explore, analyse, synthesise and collaboratively construct their knowledge from the variety of technological resources available to them. This is particularly important in a climate where information is dynamic and rapidly changing, needs to be contextualised, and where an authoritative voice is needed. As Laurillard (2013, p. 2) observes, “If we are confident in our use of technology then we can go beyond mere awareness to full exploitation of these new opportunities.” The bleak alternative is that educators are left behind and dis-empowered from shaping new paradigms of learning.

The call for such a repositioning of educators is heard from leaders in the field of technology-enhanced learning (TEL) and resonates well with the growing culture of design-based research in Education. However, it is still struggling to find a foothold in educational practice. We contend that the root causes of this discrepancy are the lack of articulation of design practices and methods, and a shortage of tools and representations to support such practices, a lack of a culture of teacher-as-designer among practitioners, and insufficient theoretical development to substantiate this.

DEFINING LEARNING DESIGN

The field of Learning Design, or as some would argue Design for Learning (Beetham & Sharpe, 2013; Laurillard, 2013), emerged from a growing recognition that the role of educators is, as Diana Laurillard phrases it: "not to transmit knowledge to a passive recipient, but to structure the learner's engagement with the knowledge, practising the high-level cognitive skills that enable them to make that knowledge their own" (Laurillard, 2008, p. 527). This view positions educational practice as an act of design, not in the artistic meaning of the word but in the sense of "as a goal-directed, problem solving activity that results in the creation of something useful that did not exist before" (Ertmer, Parisio, & Wardak, 2013). Or, as Herbert Simon declared: "Everyone designs who devises courses of action aimed at changing existing situations into preferred ones" (Simon, 1996, p. 111).

Mor and Craft (2012) define learning design as "the creative and deliberate act of devising new practices, plans of activity, resources and tools aimed at achieving particular educational aims in a given context" (p. 86). Adding that it should be informed by subject knowledge, pedagogical theory, technological know-how, and practical experience and at the same time, it should also engender innovation in all these domains and support learners in their efforts and aims.

The qualifiers "creative and deliberate" above reflect the dual nature of design (and in particular learning design) as both art and science. This positioning is informed by theoretical studies of the nature and value of design (Cross, 2001; Latour, 2008; Schön, 1992). Arguably, if we wish to develop a productive understanding of the term learning design, we should begin with a careful consideration of its constituents: "learning" and "design". There is a general agreement that learning is a fundamental capacity of humans. Yet, this capacity is so fundamental that the way it is conceptualised is contingent on the observer's framework of choice for examining human behaviour. In a landmark article, Andy Clark (2013) describes the fundamental function of the brain as predictive machine: one that uses past experiences and current sensory input to generate expectations for future sensory inputs, and then evaluates the error, or discrepancy between these expectations and the inputs eventually observed. Learning, in this perspective, is the minimisation of the error between expectations and observations. Different perspectives will yield a different conceptualisation of learning: as a change of intentional state or a change of practice – individual and social. But one element is common to all: a change in human condition. However, whereas learning is an inate human capacity, education is about directing learning towards specified objectives. Hence, as argued above, it is a domain of design.

How do we understand design? Holmberg (2014) provides an insightful discussion, juxtaposing Simon's view with Schön's. Both Simon and Schön, argues Holmberg, see teachers (and other practitioners) as designers who devise new methods and artefacts to solve problems. Yet, while Simon sees design as a rational process of problem-solving by iterative optimisation, Schön places a greater emphasis on the process of problem-*setting*. It is important to note both the commonalities and the tensions between these approaches. On the common side, design is seen as a simultaneous creative practice and a process of inquiry. It operates in complex domains, where analytical techniques often fail – and hence has to apply iterative "generate and test" methods. The difference between Simon and Schön, argues Holmberg, is that while Simon takes a positivist, "technical rationality" stance, Schön adopts a pragmatist-construtivist view. Simon holds that even ill-structured problems can be decomposed into structured ones which can be solved systematically by applying scientific principles. Schön, on the other hand, attributes much greater value to the tacit knowledge of practitioners. Real-world domains are uncertain, ambiguous, ill-defined and complex. Often the problem to be solved is only fully understood when the solution is presented. In other words, articulating the problem is half the solution – but not necessarily the first half. Following Schön, Holmberg suggests that rather than seeing design as the application of scientific principles in a practical setting, a more balanced approach is in order – in which practitioners are seen as "on-the-spot researchers", informed and informing scientists through a continuous dialogue. This proposal resonates with the ideas of *teacher inquiry* and *design inquiry of learning*, discussed below.

Mor, Craft, and Hernández-Leo (2013) consider Latour's insights on design (Latour, 2008), and their projection into learning design. Latour lists "advantages" of design: humility, attentiveness to detail, semiotic skills, remedial intent and an ethical dimension. When combined with the observations above, we derive the following assertions:

Learning design is…

- A process by which practitioners aim to achieve educational aims in a given context.
- An art: a skilled craftsmanship and creative practice.
- A science: a critical and reflective inquiry informed by theory.
- Ethically driven: education strives to make the world better, hence Learning design is tasked with understanding what "better" means, and how to get there.
- Change-oriented: responding to a changing world, realising that doing the same as before will not achieve the same results – but doing things differently can achieve better results.
- Iterative: considering the current state of affairs, perturbing it with innovations, observing the changes that ensue and repeating.
- Interleaving problem-setting and problem-solving: as we change the environment in which we operate, our understanding of that environment changes, and consequently so do our desires within it.
- Humble: acknowledging the limitations of real-world settings, and acknowledging our limitations as actors within those settings.

Admittedly, these qualifiers are a step beyond the common definitions of learning design. While we are confident that most of the experts in the field would not disagree with these statements, the definitions offered in the literature are much narrower.

The Larnaca declaration (Daziel, this volume chapter 1; Dalziel et al., 2013) provides an extensive (if admittedly, not comprehensive) timeline of the field of Learning Design. It traces the origins of the field to four strands of work in the early 2000's, mainly in the Netherlands, the UK and Australia. The Larnaca declaration states:

> The new field of Learning Design seeks to develop a descriptive framework for teaching and learning activities ("educational notation"), and to explore how this framework can assist educators to share and adopt great teaching ideas.

This definition highlights the issue of representation, as reflected in Koper's (2006, p. 13) definition:

> A 'learning design' is defined as the description of the teaching-learning process that takes place in a unit of learning (e.g., a course, a lesson or any other designed learning event). The key principle in learning design is that it represents the learning activities and the support activities that are performed by different persons (learners, teachers) in the context of a unit of learning.

Yet the work of Koper and his colleagues, first on EML and later of the specification of IMS-LD, focused on machine readable representations, which would support the automation of learning design and delivery systems. By contrast, the Larnaca declaration also acknowledges the importance of sharing effective teaching innovations among practitioners, as expressed in Conole's definition (2013, p. 121):

> A methodology for enabling teachers/designers to make more informed decisions in how they go about designing learning activities and interventions, which is pedagogically informed and makes effective use of appropriate resources and technologies. This includes the design of resources and individual learning activities right up to curriculum-level design. A key principle is to help make the design process more explicit and shareable. Learning Design as an area of research and development includes both gathering empirical evidence to understand the design process, as well as the development of a range of learning design resource, tools and activities.

Koper and Conole suggest two seemingly competing approaches. Falconer, Finlay and Fincher (2011) note that Learning Design has two roots in technology enhanced learning (TEL). The first is the construction of computer systems to orchestrate the delivery of learning resources and activities for computer-assisted learning. The second is in the need to find effective ways of sharing innovation in TEL practice, providing an aid to efficiency and professional development for teachers. Koper's definition above represents the first tradition, while Conole's is derived from the second. Note also, that Conole considers design as a verb - the process of innovation, whereas Koper refers to the noun - the product of this process. Yet both of these definitions side-step the issue of design knowledge, its formulation, communication, critique, aggregation and application. This has been a central concern of the design patterns and design principles traditions, discussed below. The discussions at the ASLD workshop and the chapters in this volume indicate a growing recognition of the need for dialogue across these traditions, which should lead to common definitions that acknowledge learning design both as a verb and a noun. Such dialogue would promote the establishment of common standards - not just in the technical sense (such as the existing IMS-LD specification), but in terms of scientific standards, best practices, and measures of quality.

Dobozy (2011, p. 9) highlights the challenges to Learning Design raised by TEL, quoting Slavin's (2008) claim that "education today is at much the same pre-scientific point as medicine was a hundred years ago", and argues that Learning Design holds a viable potential for addressing these challenges. Yet, she contends, this potential is undermined by competing traditions and terminologies and lack of clarity, as demonstrated by Berggren et al. (2005, p. 4):

> The initial immersion into Learning Design gave us an experience of confusion over terms, concepts and tools. Our group constantly mixed discussions amongst conceptual points, codified specifications and multiple tools which are in various stages of development. Teachers will need to grasp these differences before a meaningful discussion can take place.

Dobozy notes that even the basic terms are contested – the field itself is called 'learning design' (Dalziel, 2006) 'instructional design' (Chu & Kennedy, 2011) 'curriculum design' (Ferrell, 2011) 'educational design' (Goodyear & Ellis, 2011), 'design for learning' (Beetham & Sharpe, 2007), and 'design-based learning'(Wijen, 2000). While it is arguable that some of these are distinct perspectives, these distinctions need to be clarified and the synergies and overlaps among the traditions need to be explored. Cameron (2010) provides a concise review of the varying perspectives on "what is learning design". Building on this, Dobozy suggests a classification of three types of Learning Design: Type 1 'Learning Design as a concept', Type 2 'Learning Design as a process', and Type 3 'Learning Design as a product'. Her contention is that learning design workflow follows this conceptual structure, and that it is roughly sequential. Learning design must be conceptualised before it can followed as a process that leads to specific design outputs.

The lack of clarity highlighted by Berggren et al. and Dobozy is echoed by Goodyear and Dimitriadis' (2013) concern that the rapid technical and practical growth of the field is outpacing its theoretical development, running a risk of building high castles on slim foundations. We contend that this indicates that the field has reached a point where it needs to discuss its foundational frames, or what the educational design research community calls its *commissive space* and *argumentative grammar* (Cobb & Gravemeijer, 2008; Kelly et al., 2008; Kelly, 2004): the substrate of rules and assumptions which bind the discourse of a community, and the logical system by which claims are presented and justified. We offer the above characterisation of learning design as a step in that direction.

The ASLD workshop addressed key contemporary research issues in Learning Design. The workshop was organised by the three major themes: Practices, Methods, and Methodologies (Dobozy's Type 2 and to some extent Type 1), Tools and Resources (Type 2 and Type 3), and Theories and Frameworks (Type 1). The most obvious difference is that Type 3 refers to designed artefacts for learning, such as models, templates, or lesson plans describing roles and resources needed for a specific learning activity. These artefacts per se were not one of the thematic strands, but are the final result of using the methods, tools, and resources of Learning Design. For example, one might use software such as LdShake (Hernández-Leo et al., this volume chapter 14) or ScenEdit (Emin et Pernin, this volume chapter 13) to generate a model for learning. The most clear example of a Type 3 artefact is described by Walmsley in Chapter 13. Notwithstanding these slight differences, we have loosely organised the book into similar conceptual groupings, though not preserving the same sequence.

LEARNING DESIGN AND INSTRUCTIONAL DESIGN

In considering the current research in Learning Design we must also address the significant body of work in the domain of Instructional Design (ID). The two share many broadly overlapping attributes, which can lead to some confusion among both researchers and practitioners.[1] As chronicled by Reiser (2001), Instructional Design traces its origins to the Second World War and the need of the US military to rapidly train large numbers of people in performing technical tasks both for domestic production of war materiel and for combat. Learning Design is more often associated with the emergence of online and technology-enhanced learning research in the late 1990s and 2000s, though Instructional Design has embraced research in learning technologies and efficiencies in the production of adaptive teaching materials for considerably longer. But their differences stem from more than terminology or historical origin. Most notably perhaps, they have somewhat different theoretical backgrounds, with Instructional Design emerging from a behaviourist perspective, and Learning Design more from constructivist theory. This has led Instructional Design to focus on learning artefacts and methods, and in designing and delivering instruction according to instructional events and their relevance to specific psychomotor learning skills. A systematic approach to task decomposition and training characterised the early methods of Instructional Design, which were later modified with the arrival of systems engineering techniques from the domain of computing and research into cognitive load (e.g., Sweller, 1994).

By contrast, the relatively recent emergence of Learning Design research has seen more emphasis on the learner's context and in constructivist interpretations of the learning process, situated within an ecology of technological tools to support this. Perhaps due to its longer history, the use of Instructional Design has received greater attention in the US than elsewhere. MacLean and Scott (2001) also observe that the level of professional support and development for Instructional Design is more developed in the USA and Canada than in the UK. Another consequence of these different historical and theoretical perspectives is that there are both gaps and overlaps in the literatures, and the research within one community which might be particularly relevant to the other may go untapped or unnoticed. For example, acknowledgement of Instructional Design developments in the constructivist arena (Morales, 2010; Stone & Goodyear, 1995; Willis, 1995, 2009).The bodies of research remain relatively siloed and cross-publication is infrequent. Rather than take sides, we feel that it is best to recognise the differing traditions and the useful research from both communities by incorporating it into our thinking about Learning Design. This conciliatory position is also adopted in Goddard, Griffiths, and Wang (this volume chapter 9). At the same time, our work has centred upon technology-enhanced approaches to the challenging task of supporting teaching and learning, and as this is the fount from which Learning Design has emerged, it seems a more suitable title for this collection.

ISSUES AND GRAND CHALLENGES

The work in this book is indicative of the growing discourse and the vibrant community of researchers and practitioners that are shaping the field. On one hand the field is maturing, with the articulation of theoretical and methodological frameworks, the availability of a wide choice of tools, and the build-up of a canon of literature. On the other hand, several challenges are emerging as clear directions for future work. We see three pivotal issues as being most crucial to its evolution. If the promise of Learning Design research is to employ technology to improve learning, it will do this by supporting teachers and by extension, learners, who are in the end, the focus of all our efforts! But it will not live up to its potential unless it can (i) authentically represent teachers' practice in a familiar parlance, (ii) can support practitioners with useful, open tools, and (iii) can support learning design as *a design practice*. These are three of the grand challenges arising from the research in this book.

The first challenge is the standardisation of a comprehensive representational infrastructure: human-readable, textual and graphical (and perhaps dynamic) forms of describing learning design at multiple levels of abstraction. One metaphor that surfaced repeatedly at the ASLD workshop was that of musical notation. This metaphor is also examined in length in the Larnaca Declaration (Dalziel et al, 2013 and Daziel, this volume chapter 1). Musical notation enables complex, expressive, dynamic, time-based content to be captured accurately and succinctly, yet expressively. Moreover, the symbolic, formalised abstraction of the content does not impede interpretation and reproduction. On the contrary, capturing the "essence" of a musical work formally facilitates the creative expression of the composer, whilst leaving room for interpretive reproduction of musicians. Take the genre of jazz, for example. The music of Miles Davis can be interpreted in myriad ways by many musicians, without losing its essential nature. Teachers have frequently related their desire to record the essence of their practice (at various levels of detail and with kinds of activities), whilst not sacrificing their ability to be creative, due to limitations of the means of capture. Yet if pushed too far, this analogy breaks down. In the end, one would like to be able to assert that a particular teaching method or approach leads to better learning experiences among students and some formative or summative assessment metric is inevitably involved in demonstrating this. Music, a largely aesthetic endeavour, is less germane to this kind of evaluation. However, the impact of notation on dissemination, sharing, and indeed creative expression of music would be hard to understate. Another useful analogy is the language of architectural drawings. Architects design process is scaffolded by a progression through a series of graphical and other articulations of their ideas. These representations afford a discussion of the design objectives and the means chosen to address them. They eventually require the interpretation of craftsmen in order to be implemented as physical buildings, yet any professional can assess whether a certain construction matches the design prescribed in the drawings. The field of Learning Design is rich in languages but lacks common agreement around basic terminology, although recently some specific attempts have been made (Reigelugh & Carr Chelman, 2009). It enjoys an impressive array of textual, graphical and computational representations of practice and resources, yet it hasn't found the canonical "drawing" or "notation" that music and architecture have.

Once a consistent notation system is established, it can become: (1) a tool for remembering designs, (2) a structured problem-solving work space where designs can take form, and (3) a laboratory tool for sharpening and subdividing abstract design categories. Through a continuing cycle of refinement, both design language and notation system grow in parallel, and more sophisticated design ideas result" (Gibbons et al., 2008, p. 642).

In order for educators to effectively orchestrate learning within this landscape, they need to perceive themselves, and indeed to be perceived by society, as techno-pedagogical designers. A design attitude should be reflected in the production of new resources, as well as in effective configuration and customisation of existing ones. The design paradigm has established itself in TEL research. Yet, for it to attain its full desired impact, it needs to develop a common language and make this language accessible to the widest possible audience. Such a language, and the related media of interaction, should allow experts and novices to extract design knowledge from experience, articulate it in a coherent manner, connect, combine and manipulate it, and use it to resolve new challenges. These issues are the focus of the chapters in Section 1, and to some degree, in Section 2.

This leads us to the second challenge, which is the focus of Section 2: a common language of learning design needs to be supported by appropriate tools, resources and community spaces that will streamline the process of constructing, validating and using design knowledge, making it open, accessible and transparent. It cannot be a uniform, centralised entity, but must allow for a diversity of discourse by establishing a set of open protocols and standards over which large-scale open collaborative knowledge building can thrive. This process needs to be embedded in the culture of the professional community. Again, recent years have witnessed the flourishing of an impressive arsenal of learning design tools. Yet, no single tool can address the requirements of all practitioners in all situations. Nor can a single tool can provide a "round trip" solution, which must support the full cycle from inception, through challenge definition, conceptualisation, elaboration, enactment, evaluation and reflection, and back to remodelling. Thus, the question is: how do we create a platform for open, live, malleable, dynamic representations of design knowledge in TEL, supporting collaborative processes of design for learning, learning to design, and learning by design, and including the broadest community possible in these processes?

A common language of learning design and a comprehensive platform to support it are necessary but not sufficient conditions for the emergence of a professional culture of learning design. The design activity entails dealing with ill-defined problems subjected to evolving constraints. More specific guidance would benefit designers; particularly novice designers. Cross (2008) introduces the notion of 'methods' as more prescriptive and detailed descriptions of procedures (also present in literature as activities, tasks, techniques, etc.). The methods have two main features in common: they formalize certain procedures of design, and they externalize design thinking enabling the representation of solutions into concrete artifacts (drawings, charts, diagrams, etc.) of communicative and conversational power (Maina, 2012). As an example, see the COED method (Ryberg et al., this volume chapter 6).

An open platform for learning design might promote the emergence of a new culture of educational practice, in which expertise is rapidly and effectively shared, critiqued and aggregated. It will provide for the wide proliferation of cost-effective and robust educational practices, making effective use of technological advances as they appear. However, such a culture will not be instigated simply by the existence of the right tools and representations. The existing Learning Design community needs to engage in a massive project of professional development, driving a new perception of educational profession, as a rigorous creative practice of perpetual innovation. The principles underlying the Learning Design approach, the practices reifying those principles, and the methodological framework binding those together need to be made explicit and communicated to the widest audience possible.

Finally, Section 3 addresses the third challenge: the uncharted links and dimensions of a design approach to Learning Design practice need to be explored. Other design disciplines emphasise their creative and aesthetic qualities. How are these reflected in the domain of Learning Design? Should we promote them, and how? Can we evaluate the creative and aesthetic qualities of a particular learning design process or artefact? On the other hand, design approaches have recently gained prominence in educational research. Should we, and can we, forge links between design-based research and research-inspired practice? Several studies (Ronen-Fuhrmann, Kali

& Hoadley, 2008; Voogt et al., 2011) demonstrate the value of engaging in design for teachers' professional development. This is no surprise, if we acknowledge educators' continuous development as a learning process, and consider learning-by-design as a powerful pedagogical framework. Mitch Resnick (2007) calls for reconceptualising education to promote the creative society. In order to do that, we need to reconceptualise teaching as a creative practice. With this in mind, we propose a view of learning design as a grounded, rigorous, and creative process of perpetual educational innovation: grounded in a well-defined concrete context of practice, rigorous in its attention to scientific evidence and pedagogical theory, and creative in its approach to generating new solutions to educational challenges.

WHERE TO NEXT?

Before we proceed to a brief outline of the chapters of this volume, we conclude the discussion with a view to the future. Where do we see the most promising developments on the horizon?

Currently we are witnessing a growing excitement about the potential of "big data" in education. The emerging field of learning analytics promises to revolutionise the way we learn and teach by offering real-time, personalised feedback and guidance based on the analysis of large quantities of data. Proponents refer to examples from e-commerce and e-health, as well as other fields (such as epidemiology) where analysts use large data sets and powerful computational tools to identify trends and population dynamics, use these to predict individual behaviour and respond to it in an effective manner. If Amazon can use "big data" to recommend your next purchase, why can't we use the same methods to recommend your next course? Imagine the potential of a personalised automated tutor, who has the insights of observing a million learners before you – and uses that to guide you on the most effective learning path.

Indeed, learning analytics is already showing impressive results. Yet it faces considerable challenges before it can fully realise its promise. Some of these challenges are technical – e.g. how do we share data and processing power across systems, to leverage synergies and economies of scale, without compromising system stability or user privacy? Some of these challenges are ethical: how do we avoid "machine determinism" where a learner's future is induced from the data of her past, and therefore "unrealistic" option are automatically closed to her. Yet other challenges are pragmatic: most learning is still situated out of reach of logging. Even in pure distance education scenarios, learners often conduct much of their activity outside the VLE – they will download or print materials to read offline, search for supplemental content on the web, or work out exercises with pen and paper. Such activities cannot be tracked, and therefore cannot be analysed. Apart from the obvious challenge, there is a risk that where we cannot measure what we ask, we will end up only asking what we can measure. Finally, there are conceptual challenges – which are perhaps the greatest challenges of all. Learning is a much more complex process than shopping. Many great thinkers, from Socrates to Piaget and Vygotsky, demonstrated how learners must pass through states of confusion, conflict and contradiction to achieve meaningful progress. In simple terms, you cannot learn before you acknowledge that there is a gap in your knowledge or skill – and that is often an unpleasant realisation. Yet such states will appear as black marks on an analytics graph – and an automated system would attempt to avoid them.

Apart from the technical challenges, these issues point to the critical role of the dialogue between learning analytics and learning design. On one hand, learning analytics can inform and validate learning design: identify the points where re-design is called for, and confirm the effectiveness of good designs. On the other hand, learning design can give substance to the "learning" in learning analytics: without a representation of the detailed educational objectives, and the expectations in terms of the learner activities which will promote them, learning analytics is reduced to monitoring generic behaviours – such as persistence and perseverance, or social interactions. Learning design can provide a rich description of learning experiences in terms of the expected practices and activities of learners, which can then be monitored by learning analytics. The synergy between Learning Design and Learning Analytics opens up new possibilities for both. For example, it creates the option of designing learning experiences which assume the availability of learning analytics and thus incorporate checkpoints for self-reflection using the analytics outputs.

There is a third vertex to this triangle: Teacher Inquiry. We discussed Schön's notion of design as practitioner inquiry. The emerging trend of teacher inquiry (Avramides et al., 2014; Makri et al., 2014) suggests a projection of this idea into educational practice. Teacher inquiry applies the ideas of inquiry-based learning to teachers' professional development. Teachers phrase conjectures about students' learning, and conduct classroom experiments to test these. Consequently, teachers enhance both their theoretical knowledge and their practical skills. The interleaving between Learning Design and Teacher Inquiry is aligned both with Schön's conception of design as inquiry and with Simon's model of design science. Learning analytics provide the instrument for making this design inquiry of learning truly powerful. The potential of this three-way synergy has been discussed by Emin-Martínez et al. (2014) and is the subject of a forthcoming special issue of the British Journal of Educational Technology (Mor, Ferguson & Wasson, 2015).

On a more technical-pragmatic level, we see an important emerging trend in the development of integrative learning design environments. Persico et al. (2013) and Prieto et al. (2013) demonstrate the diversity of tools and representations already available in the field of Learning Design. This diversity highlights the richness of theoretical and practical approaches to the issues at hand. Yet, each one of these covers a particular phase of the learning design cycle, or embodies a specific practice. Again, the comparison to other design disciplines is helpful: an architect will often start her work with a crude sketch, using soft pencils and paper. She will then proceed through a series of ever-more-detailed and accurate representations, using progressively complex tools as she proceeds. Finally, a fully specified set of plans will be handed over to contractors for implementation. As the field of Learning Design matures, we need to move beyond the tensions between competing formats, and instead focus on open standards and platforms for seamless interchange from one format to the next. A promising step in this direction is the Integrated Learning Design Environment – ILDE (Hernández-Leo et al., 2014).

CHAPTER OVERVIEW

This book represents an effort to organise some of the contemporary research that is addressing these grand challenges of Learning Design. We have structured it according to the three major themes from the ASLD workshop from which the book has its origins whilst acknowledging Dobozy's useful conceptual Types. We turn now to a brief discussion of the chapters themselves and how they relate to this structure.

Theories and Frameworks

Theory generation can arise from both from findings of research aimed at theory building and from reflection upon practitioner experiences. Such theories can support the development conceptual frameworks to support the learning design process. In the opening section of this book, we explore some of the emergent theories and knowledge frameworks that are influencing the epistemology of Learning Design, and which address the aforementioned grand challenge of implementing a design-based approach and a culture of design practice. This is by no means a fully comprehensive picture. Rather, we aim to provide a sample of some of the current thinking in this area and which arose from the collective, collaborative experiences of participants at the ASLD 2011 workshop.

In the first chapter, Dalziel discusses the Larnaca Declaration, the work of a group of experts who met to review and reflect on the history and current state of the field. This is followed by Goodyear et al. who develop conclusions regarding the structure of networked learning environments and discuss the structural relationships between learning design patterns, and Alexandrian architectural patterns. As with Alexandrian patterns, learning design patterns have always been intended to bring learning design principles to a large audience of practitioners… Ronen-Fuhrmann and Kali address the deeply important issue of bringing theory to practice and supporting the very practitioners that researchers aim to help. They present a study of graduate students in Education – the very people who will put contemporary research in learning design into practice. They show how the students' use of an epistemological model to aid them in designing learning in TEL modules closes gaps between theoretical and applied knowledge. This work also informs the refinement of an innovative Design Principles Database which could be useful not only to students but to seasoned teachers. Finally, Pozzi, Persico and Earp conclude this section with an analysis that provides a multi-dimensional framework drawing together a number of representations for design of learning. Their analysis of the key dimensions characteirizing the existing representations for Learning Design, namely: format, level of formalism and level of contextualization, purpose, and types of end users, identifies essential areas for further investigation.

This conclusion to the thematic strand on Theories and Frameworks shines a light on the potential areas for fruitful continued research and development and provides an epistemological capstone to the thematic strands on Methods and Tools. We close the book with some reflections on these significant research opportunities and discuss the possible positive consequences for the future of Learning Design.

We believe that the bounty of enthusiastic research in Learning Design will continue to be fruitful for the key recipients of our industrious efforts: other researchers, teachers, and not least, learners. Indeed many of us within the research community have been or continue to be teachers and learners, ourselves. These communities come in many shapes and from diverse, rich traditions and cultures around the world. Yet, they face the common challenges of mutual collaboration, sharing, and support in the complex social and increasingly, socio-technical process that is 21st Century learning. The work here is emblematic of the aspirations to meeting this challenge and confirms that we are heading in the right direction, together.

Practices, Methods, and Methodologies

In the second thematic section, we review some contemporary trends in the practices, methods, and methodologies of Learning Design, from identifying and rationalising the stages of the learning design process, to evaluating the results of design work done and interpreting what is and is not effective. Much of the literature in Learning Design describes the representations or the products of design work, but not the process itself. Thus, we begin with Mckenneys' chapter addressing the gap between TEL research and practice, and how their interplay informs education innovation. In another approach to e-Learning design, Ryberg, Buus, Georgsen, Nyvang, and Davidsen describe a method that emphasizes collaboration in the design process and illustrate how this can help creating Learning Designs based on activities, resources and infrastructure. Warburton and Mor address the recent interest in Design Patterns with a unique triad of activities to yield practitioner-generated learning designs. They provide substantive and documented practices leading to theoretical and procedural development in Learning Design. Masterman notes the importance of evidence in assessing the effectiveness of the design process, using a case study to describe a method of analysing learning design software. She highlights the important consequences for Learning Design more broadly.

Concluding this thematic section, two chapters explore the importance of “getting it right” in Learning Design and explore how difficult it can be to achieve this, despite serious and well-placed efforts. The IMS-LD approach has attracted noteworthy attention within the Learning Design community and has gained a lot of support from researchers since its introduction in 2003. However, its uptake has remained relatively slow, given this level of interest. This raises interesting questions as to why progress has been so stunted. To address this, Goddard, Griffiths and Wang describe a study comprising interviews of practitioners and leading participants in the IMS-LD community which attempts to explain the limitations to its adoption. Fleshing out this picture from an applied perspective, in the concluding chapter of this thematic section, Burgos illustrates some of the practical challenges of implementing IMS-LD, providing evidence from several learning scenarios and a case study. The challenges to adoption of IMS-LD serve to illustrate both the importance and the difficulty of providing a unified foundation upon which to support learning designers and practitioners.

Tools and Resources

In addition to the difficulty of developing design practices and methods, an ancillary challenge is that there are few tools to support the learning design process itself. Many other design-focused disciplines have seen the emergence of significant software supports for their work. Architects and engineers have their CAD tools, Graphic Designers and 3D animators can choose from a range of creative suites, and there are even packages for designing performative activities such as theatrical lighting. Yet, to support the complex process of Learning Design, there are comparatively few tools to choose from. The third thematic section of this book explores some of the most recent and promising of them.

As research in Learning Design has matured, systematic approaches have led to the development of a modest number of software systems and platforms to support design activities. These implement methods of learning design at various levels of learning activity and support for sharing work with others. As a contrasting view on the challenges raised for IMS-LD in the previous thematic section, Derntl opens the third theme by describing another IMS-LD compliant system, OpenGLM, which supports the first two levels of IMS-LD design, but without the need to be an expert in the framework. It provides a set of visual representations and simple interactions to aid practitioners in designing and sharing IMS-LD based designs. Effective representations and ease-of-use are intimately intertwined. As noted extensively in Botturi and Stubbs (2007), significant challenges are raised by the difficulty of meaningfully expressing such representations. Brasher and Cross have created a tool for just this purpose, and in the subsequent chapter, reflect upon what they have learned in using and refining CompendiumLD. They show how the challenges of representation will likely become more acute as technology-supported learning designs become richer and more complex.

Familiar representations are also important for giving teachers new ways to engage with technology to enhance learning design. In the next chapter, Walmsley illustrates this principle by presenting a simple pedagogic template in the form of a Word document. She shows how this can be extremely effective for creating curriculum and tool-focused e-Learning, at this micro-level of design work, where planning individual learning activities or sessions occurs. Learning design systems can equally operate at more strategic level to support thinking about both learning and the required resources to support it. An emphasis on sharing and co-edition are the basis for a case study in the use of LdShake, described by Hernández-Leo, et al. Their focus on social-network oriented work and sharing across teams and institutions also illustrates how innovations in learning design can affect larger initiatives across schools and communities. Rounding out this panoply of software, Emin and Pernin describe both a conceptual framework for learning design and a tool, ScenEdit, which implements it. Their work straddles two thematic stands of this book, but we situate it among the other tools to highlight how tight integration of a theory-driven conceptual framework (ISiS), can be effectively manifested in software.

NOTE

[1] For an interesting overview of the lively discussions surrounding this, see 'Learning Design vs. Instructional Design', a Cloudworks discussion thread at http://cloudworks.ac.uk/cloud/view/2536. Last accessed: 26 Nov 2014.

REFERENCES

Avramides, K., Hunter, J., Oliver, M., & Luckin, R. (2014). A method for teacher inquiry in cross-curricular projects: Lessons from a case study. *British Journal of Educational Technology*, *46*, 249–264.

Beetham, H., & Sharpe, R. (2007). *Rethinking pedagogy for a digital age*. New York, NY: Routledge.

Beetham, H., & Sharpe, R. (2013). *Rethinking pedagogy for a digital age: Designing for 21st century learning*. London: Routledge.

Berggren, A., Burgos, D., Fontana, J., Hinkelman, D., Hung, V., Hursh, A., & Tielemans, G. (2005). Practical and pedagogical issues for teacher adoption of IMS learning design standards in moodle LMS. *Journal of Interactive Media in Education, 2*. Retrieved from http://jime.open.ac.uk/2005/02/

Botturi, L., & Stubbs, S. T. (2008). *Handbook of visual languages for instructional design. Theories and practices*. Hershey, PA: Information Science Reference.

Buck, G. H. (1989). Teaching machines and teaching aids in the ancient world. *McGill Journal of Education / Revue des sciences de l'éducation de McGill*, *24*(1), 31–54. Retrieved from http://mje.mcgill.ca/article/view/7845/5774

Cameron, L. (2010). How learning design can illuminate teaching practice. *In proceedings of the future of Learning Design Conference* (pp. 20–27). Australia: University of Wollongong. Retrieved from http://ro.uow.edu.au/fld/09/Program/3/

Chu, S., & Kennedy, D. (2011). Using online collaborative tools for groups to co-construct knowledge. *Online Information Review*, *35*(4), 581–597.

Conole, G. (2013). *Designing for learning in an open world*. New York, NY: Springer.

Cross, N. (2001). Designerly ways of knowing: Design discipline versus design science. *Design issues*, *17*, 49–55.

Dalziel, J. R. (2006). Lessons from LAMS for IMS learning design. In *Proceedings of the Sixth International Conference on Advanced Learning Technologies* (pp. 1101–1102) IEEE. doi:10.1109/ICALT.2006.220

Dalziel, J., Conole, G., Wills, S., Walker, S., Bennett, S., Dobozy, E., … Bower, M. (2013). *The larnaca declaration on learning design – 2013*. Retrieved December 17, 2014 from http://www.larnacadeclaration.org/

Dodd, B., Sime, M., & Kay, H. (1968). *Teaching machines and programmed instruction*. New York, NY: Penguin.

Dobozy, E. (2011). Typologies of learning design and the introduction of a "LD-Type 2" case example. *eLearning Papers*, *27*, 3–11. Retrieved from http://elearningeuropa.info/sites/default/files/asset/In-depth_27_1.pdf

Emin-Martínez, V., Hansen, C., Rodríguez-Triana, M. J., Wasson, B., Mor, Y., Dascalu, M., … Pernin, J. P. (2014). Towards teacher-led design inquiry of learning. *eLearning Papers*, *36*(1).

Ertmer, P. A., Parisio, M. L., & Wardak, D. (2013). The practice of educational / Instructional design. In R. Luckin, P. Goodyear, B. Grabowski, S. Puntambekar, N. Winters, & J. Underwood (Eds.), *Handbook of design in educational technology* (pp. 5–19). New York, NY: Routledge.

Falconer, I., Finlay, J., & Fincher, S. (2011). 'Representing practice: Practice models, patterns, bundles…'. *Learning, Media and Technology*, *36*(2), 101–127. doi: 10.1080/17439884.2011.553620

Ferrell, G. (2011). *Transforming curriculum design – transforming institutions*. Bristol, England, UK: Joint Information Systems Committee (JISC). Retrieved from http://www.jisc.ac.uk/publications/briefingpapers/2011/bpcurriculumdesign.aspx

Gibbons, A. S., Botturi, L., Boot, E., & Nelson, J. (2008). Design languages. In J. Spector, M. Merrill, J. Van Merrienboer, & M. Driscoll (Eds.), *Handbook of research for educational communications and technology* (3rd. ed., pp. 633–645). New York, NY – London: Lawrence Erlbaum Associates.

Goodyear, P., & Dimitriadis, Y. (2013). In medias res: Reframing design for learning. *Research in Learning Technology, 21*. doi: 10.3402/rlt.v21i0.19909

Goodyear, P., & Ellis, R. (2007). Students' interpretations of learning tasks: Implications for educational design. In R. J. Atkinson, C. McBeath, S. K. A. Soong, & C. Cheers (Eds.), *Proceedings of the ASCILITE 2007 conference* (pp. 339–346). Singapore. Retrieved from http://www.ascilite.org.au/conferences/singapore07/procs/goodyear.pdf

Gravemeijer, K., & Cobb, P. (2006). Design research from a learning design perspective. In J. V. den Akker, K. Gravemeijer, S. McKenney, & N. Nieveen, *Educational design research* (pp. 17–51). New York, NY: Routledge.

Hernández-Leo, D., Asensio-Pérez, J. I., Derntl, M., Prieto, L. P., & Chacón, J. (2014). ILDE: Community environment for conceptualizing, authoring and deploying learning activities. *Proceedings of 9th European Conference on Technology Enhanced Learning* (pp. 490–493), EC-TEL 2014, Graz, Austria.

Holmberg, J. (2014). Studying the process of educational design - revisiting Schön and making a case for reflective design-based research on teachers 'conversations with situations'. T*echnology, Pedagogy and Education*, *23*(3), 1–18.

Kelly, A. (2004). Design Research in Education: Yes, but is it Methodological? J*ournal of the Learning Sciences, 13*(1), 115–128.

Kelly, A. E., Baek, J. Y., Lesh, R. A., & Bannan-Ritland, B. (2008). Enabling Innovations in Education and Systemizing their Impact. In A. E. Kelly, R. A. Lesh, & J. Y. Baek, *Handbook of design research methods in education* (pp. 3–18). New York, NY: Routledge.

King, A. (1993). From sage on the stage to guide on the side. *College teaching, 41*(1), 30–35.

Koper, R. (2006). Current research in learning design. *Educational Technology & Society, 9* (1), 13–22.

Latour, B. (2008). A cautious prometheus? A few steps toward a philosophy of design (with Special Attention to Peter Sloterdijk). In J. G. Fiona Hackne & V. Minto (Eds.), *Proceedings of the 2008 Annual International Conference of the Design History Society* (p./pp. 2–10). Florida, US: Universal Publishers.

Laurillard, D. (2008). Technology enhanced learning as a tool for pedagogical i nnovation. *Journal of Philosophy of Education, 42*, 521–533.

Laurillard, D. (2013). *Teaching as a design science: Building pedagogical patterns for learning and technology*. New York, NY: Routledge.

Maina, M. (2012). Developing a method for the design of sharable pedagogical scenarios. In N. Alias, & S. Hashim (Eds.), *Instructional technology research, design and development: Lessons from the field* (pp. 86–101). Hershey, PA: Information Science Reference. doi:10.4018/978-1-61350-198-6.ch006

Makri, K., Papanikolaou, K., Tsakiri, A., & Karkanis, S. (2014). Blending the community of inquiry framework with learning by design: Towards a synthesis for blended learning in teacher training. *The Electronic Journal of e-Learning , 12*(2), 183–078.

Mor, Y., & Craft, B. (2012). Learning design: Mapping the landscape. *Research in Learning Technology, 20.*

Mor, Y., Craft, B., & Hernández-Leo, D. (2013). Editorial: The art and science of learning design. *Research in Learning Technology, 21.*

Mor, Y., Ferguson, R., & Wasson, B. (2015). Editorial: Learning design, teacher inquiry into student learning and learning analytics: A call for action. *British Journal of Educational Technology*, *46*, 221–229. doi: 10.1111/bjet.12273

Morales, C. R. (2010). Constructivist instructional design: A blueprint for online course design. In H. Song & T. Kidd (Eds.), *Handbook of research on human performance and instructional technology* (pp. 24–42). Hershey, PA: Information Science Reference. doi:10.4018/978-1-60566-782-9.ch002

Persico, D., Pozzi, F., Anastopoulou, S., Conole, G., Craft, B., Dimitriadis, Y., Hernández-Leo, D., Kali, Y., Mor, Y., Pérez-Sanagustín, M., & Walmsley, H. (2013). Learning design rashomon I – Supporting the design of one lesson through different approaches. *Research in Learning Technology, 21*.

Prieto, L. P., Dimitriadis, Y., Craft, B., Derntl, M., Émin, V., Katsamani, M.,… Villasclaras, E. (2013). Learning design rashomon II - exploring one lesson through multiple tools. *Research in Learning Technology, 21.*

Reigeluth, C. M., & Carr-Chellman, A. A. (2009). Understanding instructional theory. In C. M. Reigeluth & A. A. Carr-Chellman (Eds.), *Instructional-design theories and models, volume III: Building a common knowledge base* (pp. 3–26). New York, NY: Routledge.

Reiser, R. (2001).A history of instructional design and technology: Part II: A history of instructional design. *Educational Technology Research and Development, 49*(2), 57–67. doi:10.1007/BF02504928

Resnick, M. (2007). Sowing the seeds for a more creative society. *Learning and Leading with Technology, 35*(4), 18–22 .

Schön, D. A. (1992). Designing as reflective conversation with the materials of a design situation. *Knowledge-Based Systems, 5*, 3–14

Slavin, R. E. (2002). Evidence-based education policies: Transforming educational practice and research. *Educational Researcher, 31*(7) , 15–21. doi: 10.3102/0013189X031007015

Slavin, R. E. (2008). Evidence-based reform in education: What will it take? *European Educational Research Journal, 7*(1), 124–128. doi:10.2304/eerj.2008.7.1.124 Hoboken, NJ: Wiley.

Stone, C., & Goodyear, P. (1995). Constructivism and instructional design: Epistemology and the construction of meaning. Originally published in Spanish (in 1995) as "Constructivismo y diseño instruccional: Epistemology construccion del significado". *Substratum: Temas Fundamentales en Psicologia y Educacion, 2*(6), 55–76.

Sweller, J. (1994). Cognitive load theory, learning difficulty, and instructional design. *Learning and Instruction, 4*(4), 295–312. doi: 10.1016/0959-4752(94)90003-5

Voogt, J., Westbroek, H., Handelzalts, A., Walraven, A., McKenney, S., Pieters, J., & de Vries, B. (2011). Teacher learning in collaborative curriculum design. *Teaching and Teacher Education, 27*(8), 1235 - 1244. doi: 10.1016/j.tate.2011.07.003

Wijen, W. (2000). *Towards design-based learning*. OGO brochure, No 2. Educational Service Centre. Eindhoven, NL: Technische Universiteit. Retrieved from http://w3.tue.nl/fileadmin/stu/stu_oo/doc/OGO_brochure_1_EN.pdf

Willis, J. (1995). A recursive, reflective instructional design model based on constructivist-interpretivist theory. *Educational Technology, 35*(6), 5–23.

Willis, J. (2009). *Constructivist instructional design (C-ID): Foundations, models, and examples.* USA: Information Age Publishing.

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SECTION 1

THEORIES

JAMES DALZIEL

1. REFLECTIONS ON THE ART AND SCIENCE OF LEARNING DESIGN AND THE LARNACA DECLARATION

INTRODUCTION

The Larnaca Declaration on Learning Design (Dalziel et al., 2013) provides a new synthesis of key concepts in the field of Learning Design, arising from a meeting of experts originally held in Larnaca, Cyprus in September 2012. This meeting grew out of several prior meetings supported by an Australian Learning and Teaching Council National Teaching Fellowship to the author (2011–2013), and "pedagogic planner" meetings in earlier years co-hosted by the author and Diana Laurillard.

These meetings had struggled to find a way to describe the conceptual foundations of Learning Design – in particular: the core concept of a "neutral" descriptive framework for many different kinds of teaching and learning activities; the wider context for teacher-led designing of activities in education; and the role of theory and practice in achieving effective learning outcomes for students.

This chapter provides an overview of the Larnaca Declaration, followed by reflections on the role of "art" and "science" in learning design processes, viewed through the lens of the Larnaca Declaration.

THE LARNACA DECLARATION ON LEARNING DESIGN

Today's learners, educators, institutions and governments face complex challenges, especially regarding 21st Century Skills/Graduate Attributes, and the appropriate use of technology. Learning Design, as a domain of inquiry and as a field of practice, aims to help these stakeholders devise effective responses to today's challenges. The Larnaca Declaration discusses the relevance of Learning Design for all disciplines and all levels of education (school, university, vocational and professional training) while acknowledging that the primary areas of interest to date have been schools and universities.

One of the core tenets of Learning Design is the concept of a descriptive framework for teaching and learning activities. The analogy of musical notation is helpful in understanding this concept, and the Larnaca Declaration uses this analogy extensively. After noting that in the past some argued that music notation was impossible, because music was too "ethereal":

M. Maina et al. (Eds.), The Art & Science of Learning Design, 3–14.

> … over many years the Western music tradition slowly developed a notational system for describing and sharing musical ideas. This standard format allowed great musical ideas to be shared from one musician to another without a need for personal contact.
>
> … Music notation does not capture everything about musical ideas – there remains a significant role for performers to bring their own interpretations to music. But musical notation contains *enough* information to convey musical ideas from one person to another over time and space.

Music notation does not guarantee beautiful music – indeed, mediocre music can be written down just as precisely as beautiful music. Music notation allows for many different styles of music to be described using a single notational framework (p. 2, Larnaca Declaration).

These ideas are then applied to “educational notation” (ie, Learning Design) – the concept of describing the structure and flow of activities that educators and learners perform in classrooms and in online environments.

Just as Western music notation provides a framework for describing many different styles of music (eg, Baroque, Classical, Romantic, etc), as well as beautiful and mediocre examples within each of these styles; so too a unified descriptive framework for teaching and learning could describe many different pedagogical approaches (instructivist, constructivist, cognitive, etc) and more and less effective examples of these approaches.

Such a framework need not describe *everything* about the educational experience; rather, it would seek to provide *enough* information in order to allow one educator to replicate the effective teaching and learning ideas of another educator. This focus gives primacy to the idea of sharing teaching and learning ideas, which has been central to the field of Learning Design (eg, Conole, 2013), and technologies to support sharing (eg, LAMS Community, Cloudworks – see Conole & Culver, 2010).

However, there is an important difference between a typical musical performance and a classroom experience is that music is usually reproduced “as is”, whereas many educators would adapt and change any shared idea to best suit their learners. This phenomenon finds a parallel with music like Jazz, where improvisation and adaptation is part of the musical experience, even though the outcome could still be notated.

Finally, 21st Century Skills/Graduate Attributes and other educational reforms often expect educators to use new teaching approaches, such as Problem-Based Learning, Role Plays, etc. Learning Design can encourage the adoption of new teaching approaches by making explicit the step-by-step process of these teaching approaches, and fostering the sharing of these processes using a common descriptive framework. It notes that wider sharing of effective teaching practices has not only pedagogical benefits (through improved student learning outcomes), but also productivity benefits (through decreased educator preparation time, arising from re-using effective ideas from other educators). The potential of sharing educational design knowledge is illustrated by two chapters in this volume: Ryberg et al., Chapter 6, and Hernández-Leo et al., Chapter 14.

Learning Design Timeline and Example

The origins of the field of Learning Design can be summarised based on four foundational projects:

> the work of Koper and colleagues on EML (Koper, 2001) and its input into the IMS Learning Design specification (IMS GLC, 2003); the work of Laurillard, Conole, Beetham and many others in the UK in the early 2000s, such as the SoURCE project (Laurillard & McAndrew, 2002); the Australian Universities Teaching Committee's Learning Design project, led by Ron Oliver, Barry Harper, John Hedberg and Sandra Wills; andthe Learning Activity Management System (LAMS) project led by the author.

For a timeline of subsequent developments in the field of Learning Design, covering many different communities, projects, tools and publications see the Larnaca Declaration (p. 7) or http://learningdesigntimeline.wordpress.com/ (note that the timeline, while broad-ranging, is not comprehensive).

To provide a more concrete example of a particular learning design for discussion, the Larnaca Declaration uses an example of a Role Play, and its representation in the LAMS software (see Figure 1). It notes that the example conveys information at three levels: an overall visualisation of the whole teaching and learning process; specific information about each individual task (such as the text of a question or a discussion topic, or a digital resources to view such as a video, etc); and a set of embedded XML instructions (not seen by the educator) to tell a Learning Design software system how to enact the overall flow of activities with the specific information required for each activity. Note that only the first of these three levels is visible in Figure 1. Other learning design examples included in the Larnaca Declaration including the AUTC Project "flow" diagram (AUTC, 2002), education patterns (Hernandez-Leo et al., 2006) and other course representations. Other chapters in this volume discuss additional tools and representations, such as CompendiumLD (Brasher & Cross, this volume Chapter 11), OpenGLM (Derntl, this volume Chapter 12), ScenEdit (Emin et Pernin, this volume Chapter 13), while Pozzi, Persico and Earp (this volume Chapter 4) propose an approach to mapping different representations.

A key point arising from these examples is that unlike Western music notation, Learning Design is yet to develop a comprehensive and broadly agreed framework for describing teaching and learning activities, and hence each example given is a kind of "proto-Learning Design descriptive framework" – that is, a "taste" of a possible future comprehensive descriptive framework, each with different emphases.

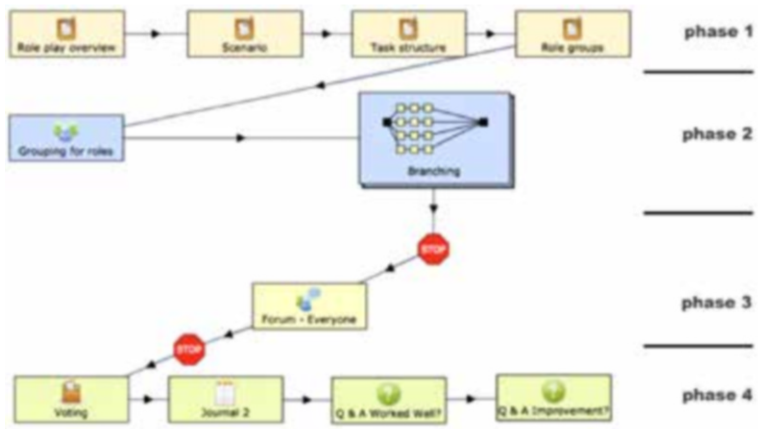

Figure 1. LAMS Authoring view of Role Play, with phases added (right side)

Definitional and Conceptual Issues in Learning Design

Definitional issues have been a significant challenge in the field, particularly for the phrase "Learning Design". The Larnaca Declaration proposes a number of clarifying phrases (listed in the Appendix) to aid discussion:

> Learning Design (capitalised): The field of Learning Design a learning design (uncapitalised): An individual example of a sequence of teaching and learning activities, also called a "design" or "sequence". A learning design is a plan for potential activities with learners, which is to be distinguished from a particular implementation of this plan with a particular group of learners (see "a running learning design") a running learning design: The implementation of a learning design with a particular group of learners, also called "a running sequence". IMS Learning Design: An example of a technical language for implementing the concepts of Learning Design in softwareteaching strategy: An approach to teaching that proposes a particular sequence of teaching and learning activities based on certain pedagogical assumptions… for example, Problem Based Learning, Predict – Observe – Explain, Role Plays and WebQuests. A teaching strategy can provide a pedagogical rationale as well as a suggested structure of activities for a learning design. (pp. 35–36, Larnaca Declaration)

For further discussion of IMS Learning Design see the chapters in this volume by Burgos (this volume Chapter 10), and Goddard, Griffiths and Wang (this volume Chapter 9). Beyond these clarifications, there is a deeper conceptual challenge in the idea of the "pedagogic neutrality" of a descriptive framework for Learning Design. Although no descriptive framework can be totally neutral, it can nonetheless aspire to being as neutral as possible – that is, an ideal Learning Design descriptive framework is able to describe many different pedagogical approaches within a single representational approach (just as music notation can represent many different styles of music).

Learning Design Conceptual Map

One of the major new elements of the Larnaca Declaration for the field of Learning Design is the "Learning Design Conceptual Map". This arose from discussion in Larnaca of the need for a wider view of the educational context in which Learning Design occurs, and the wide range of factors that affect design decisions. The Map seeks to reuse the idea of "neutrality" by incorporating a diverse range of elements that can affect design decisions, but without trying to specify a particular pedagogical theory about how they *should* interact.

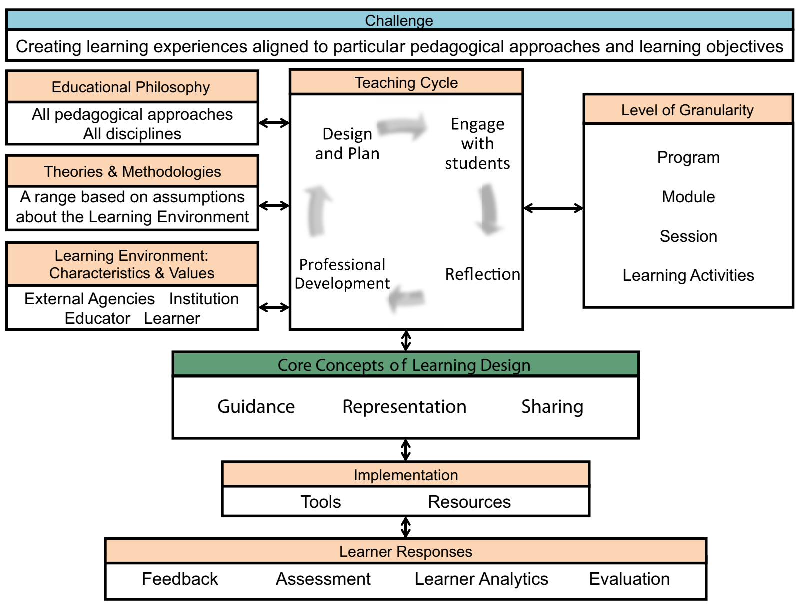

Figure 2. A Learning Design Conceptual Map (p. 14, Larnaca Declaration)

The Map notes the core concepts of Learning Design as representation and sharing, as well as guidance – that is, advice to educators on how to implement (and adapt) a particular learning design. Above this is an acknowledgement of the cycle that educators go through in teaching ("Teaching Cycle"), both in the immediate context of planning and implementing a class, as well as longer-term processes of reflection and professional development. These design processes are themselves affected by wider contextual factors, such as educational philosophy and methodologies, and the characteristics and values of educators and learners, as well as institutions and external agencies. From a different perspective, the design process is also affected by the level of granularity in design – whether this is at the level of individual learning activities within a class, or the sequence of activities over a whole class or session, as well as wider "curriculum design" issues in the planning of whole modules, and whole degree programs.

In terms of implementation, the Map acknowledges the role of Learning Design tools and other resources (whether digital or physical) in implementing a particular learning design, and finally the key role of learner responses, including feedback such as immediate reactions, assessment performance, student evaluation of courses, and, where digital data are available, the potential for analytics arising from rich records of student activity (which can be captured by some Learning Design systems).

The Larnaca Declaration provides detailed discussion of each element of the Map, and how it relates to the "micro" task of designing and implementing particular learning designs, as well as the "macro" task of how an educator goes about educational design in the general. It also gives examples of how the Map can be used to analyse particular pedagogical theories: how each theory emphasises certain elements of the Map more than others, and how comparing two different pedagogical theories, as overlayed on the Map, illustrates their areas of common interest and their differences.

Learning Design, Pedagogical Theories and Effectiveness

Having laid the foundations described above, it is possible to consider again the thorny question of *effective* teaching and learning in Learning Design, and the role of pedagogical theories such as Instructivism, Constructivism, etc. Simply "notating" a teaching and learning experience is no indicator of its effectiveness (just as a beautiful or mediocre piece of music can equally be notated using the same music notation framework).

The Learning Design Conceptual Map provides a way of examining whether a particular learning design is well aligned to its wider context, and the importance of appropriate alignment of individual activities with wider requirements, assessment, etc.

Following from this, different pedagogical approaches can be better suited to particular contexts – that is, different topics, different types of students, different levels of education, etc. Educators make regular judgements about which teaching approaches are most effective for their particular groups of students, and these decisions are informed by professional practice, as well as broader assessment of learners, and by educational research.

The Larnaca Declaration argues that while all learning ideally seeks to be student-centric, in the sense of ultimately focussing on effective learning outcome for students, this does not mean that all teaching and learning activities need to be student-directed – indeed, lecturing and direct instruction may be the most effective learning methods for certain contexts. This argues for a plurality of teaching and learning methods driven by their effectiveness in achieving appropriate student learning outcomes, and the central role of the educator in making judgements about effective methods, drawing on the wide range of potential teaching and learning methods that can be described and shared using a Learning Design framework (for further exploration of the effectiveness of Learning Design tools in supporting teaching practices, see Masterman (this volume Chapter 8).

This approach suggests that the field of Learning Design involves three related but distinct concepts – the idea of a "neutral" descriptive framework, the wider conceptual map, and a third concept for describing the practice of designing and implementing *effective* teaching and learning (drawing on the discussion above). These three concepts are described in Figure 3.

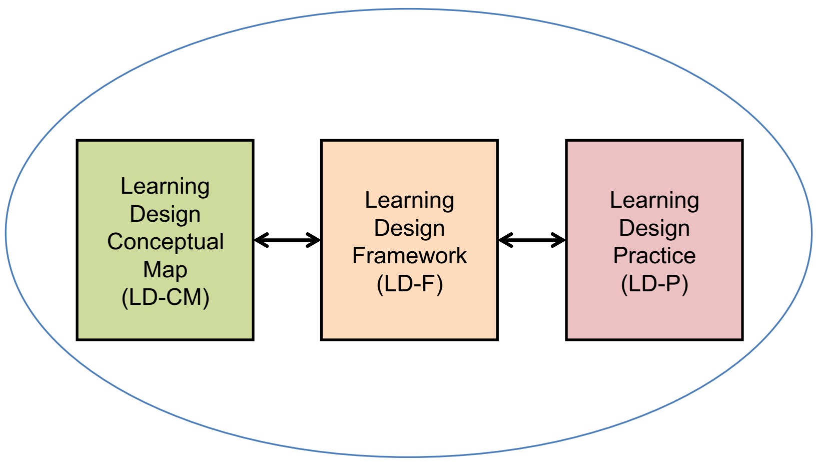

Figure 3. Components of the field of Learning Design (p. 32, Larnaca Declaration)

The Larnaca Declaration concludes with reflections on the potential limitations of the field, particularly the question of whether a broad, widely agreed descriptive framework is possible. It suggests that even if this goal proves unrealisable, the quest itself should teach us important lessons about the unique nature of education and the limits of attempting standardised descriptions of teaching and learning.

A seven point summary of Learning Design from the perspective of the Larnaca Declaration is:

- Representing learning designs in formal ways (LD-F)
- Sharing and re-using learning designs
- Encouraging localisation of learning designs for the needs of learners, and adaptation to different disciplines
- Focusing on pedagogy in all its forms across all sectors and disciplines (LD-CM)
- Applying the teaching cycle to implementing and improving learning designs

- Emphasising how learners learn, and hence how educators can teach effectively (LD-P)
- Building software to implement and share learning designs (p. 35, Larnaca Declaration)

THE SCIENCE OF LEARNING DESIGN

From the perspective outlined above, there are a number of reflections that can be offered on the "art and science" of Learning Design. In terms of "science", the work of educational research on investigating effective and ineffective teaching methods is particularly important to Learning Design – Practice (LD-P). The many findings of the fields of instructional design, learning science, educational psychology and neuroscience all have implications for how educators make choices about the most effective practices for their context. The synergies between Learning Design and Educational Design Research are explored in this volume by Ronen-Fuhrmann and Kali (this volume Chapter 3) and by McKenney (this volume Chapter 5).

Going further, Learning Design offers a more precise way to specify the steps taken in a sequence of teaching and learning activities, and this may allow for more precise comparisons of teaching methods during educational research (Dalziel, 2009). A careful ex post facto notation of the individual steps in two different teaching scenarios may help to identify the particular reason(s) for differences in outcomes, and subsequent confirmatory research can use a Learning Design descriptive framework to carefully describe the planned similarities and differences between an experimental group and a control group. This indicates how a Learning Design Framework (LD-F) could improve the quality of educational research through greater precision in comparisons. Goodeyear et al. (this volume Chapter 2) in this volume provide a vivid example of how Learning Design representations can support structural analysis of educational practices, which engender new theoretical insights.

From a different perspective, the science of structure and representation may be relevant to formulating Learning Design Frameworks. Unlike empirically driven research (such as education, chemistry, etc), the science of mathematics is, in a sense, the science of structure. The related fields of logic and computer programming also face the challenge of effective methods of representation for abstract concepts and structures. There may be valuable lessons to be learned from these sciences to inform the further development of a broad Learning Design Framework.

For example, in the Unified Modelling Language (UML – see Fowler, 2004), a key concept of representing software is that more than one representation/visualisation is required (given the complexity of software) and that each kind of representation conveys different types of information about a given example of software. It is possible that a future broad Learning Design Framework will not be just a "single" representation/visualisation (like music notation), but rather a group of different representations/visualisation, due to the complexity of describing teaching and learning processes (like UML).

THE ART OF LEARNING DESIGN

The rise of Learning Design has been, in some ways, a challenge to the concept of educational design as only "art" – as it tries to make explicit and shareable the design decisions of educators which in the past have usually been implicit. At times there has been an unfortunate tension between implicit art and explicit description in education, whereas a different way to approach the issue is to see the increasingly explicit description of education as a way of assisting educators to become more conscious of their often "pre-conscious" design processes, and based on this, to be able to add more "art" on top of their increasingly explicit underlying decisions.

This is particularly important for the issue of teaching "in the moment" – the decisions that educators makes in real-time as they watch their classes closely (in face to face environments), and how they adapt their teaching in response to their students' responses (see "Engage with learners" in the Teaching Cycle and "Feedback" in Learner Responses in the Learning Design Conceptual Map – LD-CM). As this aspect of education has to date been relatively weak in Learning Design, some educators have initially responded quite poorly to the ideas of Learning Design, as they feel this element of "live adaptation" is so central to their self-image as teachers that any approach that appears to give it less emphasis is undesirable.

In the context of the current discussion, it provides an excellent example of how the "art" of teaching remains an important part of the overall challenge of education, and hence of Learning Design as a whole. In the Larnaca Declaration this challenge is noted, and a comparison with the "improvisation" of Jazz is offered as a musical analogue to consider. Nonetheless, there are important aspects of effective teaching and learning that rely on the "real-time" attention and flexibility of educators, and this deserves further research and explication within Learning Design theory.

A second example of art in Learning Design is the sense that, when designing a set of teaching and learning activities, sometimes a particular choice "just feels right". This is most common for educators with significant experience in teaching their discipline and the typical challenges faced by learners. In terms of sharing, when an experienced educator hears of a teaching idea from a colleague in the same discipline, he or she may immediately sense its appropriateness ("it just feels right"), and hence seek to incorporate it into his or her own teaching. As noted elsewhere, even when educators do not directly re-use or adapt a particular learning design they have seen elsewhere, they may still be inspired by the essence of a learning design, and hence when they next design a set of activities "from scratch", they may nonetheless use the idea as inspiration for their new design (Dalziel & Dalziel, 2011).

THE ART AND SCIENCE OF LEARNING DESIGN

Going further, the sense that a teaching and learning idea “just feels right” can be seen as a combination of both the art and science of Learning Design. The “just right feeling” will typically arise from an intuitive grasp of the challenges of teaching a particular topic and the genuine needs of learners in this area. Even when this intuition is hard to verbalise, it can nonetheless be based on personal “empirical” experiences of effective teaching and learning in this context. Hence, an educator’s intuitive sense of the appropriateness of a new idea, which may feel like the “art” of Learning Design, may in fact be based on accurate perceptions of the challenges of teaching in this context.

However, educators’ impressions of effectiveness are not infallible, and hence a further benefit of the “science” of Learning Design is the potential for careful educational research on ideas that feel “just right”, in order to determine whether their actual impact on student learning is effective in the way that an educator assumes. In other words, there is an interplay of both art and science in Learning Design, both in the “moment” of design, and in subsequent evaluation of the effectiveness of any given design.

As Learning Design becomes more mature as a field, and develops a more widely adopted descriptive framework(s), more “teaching strategies” (see definitions above) will be documented using Learning Design and hence more widely shared, and this, in turn, will provide more precise foundations for careful educational research to determine the effectiveness of different teaching strategies in different contexts.

CONCLUSION

The Larnaca Declaration provides a new way to integrate core concepts in the field of Learning Design, particular the concept of a descriptive framework (LD-F), the wider educational context that affects Learning Design decision (LD-CM), and the practice of designing *effective* teaching and learning experiences (LD-P). The music notation metaphor provides a useful way of thinking about how Learning Design seeks to describe (and share) examples of teaching and learning that can instantiate many different pedagogical theories. The music notation metaphor also offers an analogy for thinking about the effectiveness (or otherwise) of particular learning designs for learners that have been described and shared using a broad Learning Design Framework. Both the art and science of Learning Design are important to the Larnaca Declaration approach, particularly issues such as: moving from implicit to explicit descriptions of teaching; “improvisation” in teaching; the possibilities for representation; and the interplay between Learning Design and educational research. Teaching will continue to be a challenging “art”, but it can be enhanced by the “science” of careful description of effective teaching and learning ideas, and by “artful” sharing and adaptation.

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Before and after the Larnaca meeting, a number of other meetings discussed similar issues, and these discussions contributed to the Larnaca Declaration. Participants in these other meetings have included: Diana Laurillard, Spyros Papadakis, Chris Alexander, Liz Masterman, Sheila MacNeill, Scott Wilson, Yannis Dimitriadis, Peter Goodyear, John Hedberg, Gregor Kennedy, Paul Gagnon, Debbie Evans, Kumiko Aoki, Carlos Alario, Chris Campbell, Matthew Kearney, Ron Oliver, Shirley Agostinho, Lori Lockyer and others. The Larnaca Declaration authors are grateful to all their colleagues for their insights.

REFERENCES

AUTC Learning Design (2002). *Predict – Observe – Explain: Designer's voice – Context.* Retrieved from http://www.learningdesigns.uow.edu.au/exemplars/info/LD44/more/03Context.html

Conole, G. (2013). *Designing for learning in an open world*. New York, NY: Springer.

Conole, G., & Culver, J. (2010). The design of cloud works: Applying social networking practice to foster the exchange of learning and teaching ideas and designs. *Computers & Education*, *54*(3), 679–692.

Dalziel, J. (2003). Implementing learning design: The learning activity management system (LAMS). In G. Crisp, D. Thiele, I. Scholten, S. Barker, & J. Baron (Eds.), *Interact, integrate, impact: Proceedings of the 20th Annual Conference of the Australasian Society for Computers in Learning in Tertiary Education. Adelaide, 7–10 December 2003*. Retrieved from http://ascilite.org.au/conferences/adelaide03/docs/pdf/593.pdf

Dalziel, J. (2009). Prospects for learning design research and LAMS. *Teaching English with Technology*, *9*(2), 1–4.

Dalziel, J., & Dalziel, B. (2011). Adoption of learning designs in teacher training and medical education: Templates versus embedded content. In L. Cameron & J. Dalziel (Eds.), *Proceedings of the 6th International LAMS & Learning Design Conference 2011: Learning design for a changing world* (pp. 81–88).

Dalziel, J., Conole, G., Wills, S., Walker, S., Bennett, S. Dobozy, E., ... Bower, M. (2013). *The larnaca declaration on learning design – 2013*. Retrieved from www.larnacadeclaration.org

Hernández-Leo, D., Villasclaras-Fernández, E. D., Asensio-Perez, J. I., Dimitriadis, Y., Jarrín-Abellán, I. M., Ruiz-Requies, I., & Rubia-Avi, B. (2006). COLLAGE: A collaborative learning design editor based on patterns. *Educational Technology and Society*, *9*, 58–71.

IMS GLC (2003). *Learning design specification*. Retrieved from http://www.imsglobal.org/learningdesign/

Koper, E. J. R. (2001). *Modelling units of study from a pedagogical perspective: The pedagogical metamodel behind EML*. Heerlen: Open Universiteit Nederland. Retrieved from http://eml.ou.nl/introduction/docs/ped-metamodel.pdf

Laurillard, D., & McAndrew, P. (2002). *Virtual teaching tools: Bringing academics closer to the design of e-learning*. Retrieved from http://kn.open.ac.uk/public/getfile.cfm?documentfileid=7517

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2. ANALYSING THE STRUCTURAL PROPERTIES OF LEARNING NETWORKS

Architectural Insights into Buildable Forms

OVERVIEW

A good repertoire of methods for analysing and sharing ideas about existing designs can make a useful contribution to improving the quality and efficiency of educational design work. Just as architects can improve their practice by studying historic and contemporary buildings, so people who design to help people learn can get better at what they do by understanding the designs of others. Moreover, new design work often has to complement existing provision, so the sensitive analysis of what already exists is an essential part of enhancing, rather than undermining, prior work (Goodyear & Dimitridis, 2013). Since many factors can affect what and how people learn, the scope of analysis for design is broad. In fact, it has to go beyond what has been explicitly designed for learning, to take into account the various configurations of things, places, tasks, activities and people that influence learning. Part of the skill of analysis is knowing how to put a boundary on what one studies (Hutchins, 2010). We believe that analysis of this kind can help improve the design of all kinds of technology-enhanced learning (TEL) systems. But to focus our argument, this chapter draws on our recent collaborative analyses of *learning networks* (Carvalho & Goodyear, 2014). Our thinking has been influenced quite strongly by the writings of Christopher Alexander on the properties that 'give life' to places and artefacts. The first part of the chapter has an ontological function – since analysis involves some decisions about the nature of the existence of its objects of inquiry. The second part illustrates the application of some of Alexander's ideas to the analysis of the structural properties of learning networks, where the goal of analysis is to inform design.

NETWORKED LEARNING AND LEARNING NETWORKS

Networked Learning

The empirical and conceptual work in which we are collectively engaged is located within the field of 'networked learning' (Steeples & Jones, 2002; Goodyear et al.,

M. Maina et al. (Eds.), The Art & Science of Learning Design, 15–29.

2004; Wenger, Traynor, & de Laat, 2011; Carvalho & Goodyear, 2014). The term 'networked learning' is used to denote situations in which people collaborate in a shared enterprise of knowledge creation, using digital communications technologies (such as email, online forums or blogs) to support much of their interaction.[1] Our conception of learning and knowledge creation is very broad and we deliberately choose for analysis learning networks that test the boundaries of conventional ideas about what it means to come to know. For example, changing one's sense of self as a by-product of engaging in a collective project falls within our definition of networked learning. So does contributing new-to-the-world knowledge in a distributed scientific research project.[2]

A sense of *sustained engagement with others* is an important part of this conception of networked learning. It is hard to pin this down precisely. The act of looking something up on Wikipedia would not, in itself, constitute networked learning (in our view). Collaborating with other people to create and improve Wikipedia entries probably would.

Networked learning is sometimes set within programs of formally organised educational provision[3] but that need not be the case. There are numerous examples of *informal* learning networks and of networks that provide learning and development opportunities within and between business organisations (Harasim et al., 1997). Many of the activities that James Gee (2005) associates with online 'affinity spaces' overlap with those that we call 'networked learning'. We deliberately speak of learning because we have a particular commitment to improving design for learning, rather than to the more diffuse goal of designing attractive affinity spaces. This helps sharpen the sense of *what* (structurally) is available to be analysed.

Learning Networks

We focus on 'learning networks' rather than 'affinity spaces' or 'learning communities'. Affinity spaces, according to Gee, are the places or sets of places (usually online) in which people congregate to partake of a shared endeavour. The focus is on place and activity. Learning communities, according to Wenger et al., are defined by membership, identity and shared history. The focus is on social relations and activity. When we speak of 'learning networks' we include place, membership, identity, history and activity. We also acknowledge the fluidity and changing topology of networks. But most of all, our interest in design for learning means that we also pay close attention to the *epistemic purposes* of the network – what is it that participants in the network are coming to know? In other words, our curiosity is influenced by a desire to understand how to design for networked learning.

The term 'learning network' has been in common use since the late 90s (Harasim et al., 1997; Mayadas, 1997). It is normally taken to include people and their relations and also (digital) tools and artefacts of various kinds. At that time, collaborating over the Internet was new enough for its most obvious roles, artefacts and technologies to be taken as the norm: students, instructors, experts; course notes, libraries; desktop computers, modems, cables, etc. As time has passed and technology developed, the conception of a learning network has become less clear cut – multiple people in diffuse roles can collaborate and communicate in multiple ways using a miscellany of devices and online artefacts. The networks we have analysed vary considerably in scale and complexity (Carvalho & Goodyear, 2014). Some of the more complex examples involve multiple software platforms, diverse sets of activities ('activity bundles'), hundreds of online artefacts and thousands of participants. They have evolved over several years. Mapping them is a demanding task and the resulting maps occasionally surprise the people who manage the networks concerned (Pinto, 2014). Looking at such learning networks feels more like visiting a town or city than examining the simple artefacts, interfaces or activities that are the standard fare of TEL design.

Approaches to the Analysis of Learning Networks

Over the last 40 years or so, there has been a deepening interest in network forms of organisation, across a number of areas of the human sciences (notably in sociology, economics, geography and management – see for example Haggett & Chorley, 1969; Granovetter, 1983; Castells, 1996; Podolny & Page, 1998; Borgatti & Foster, 2003; Knappett, 2013). Researchers have developed, or appropriated, a number of tools for analysing and/or modelling selected characteristics of networks (see e.g. Barabási, 2002). A number of these tools and methods are used to describe topological features of networks. Within the smaller field of networked learning research, most of the analytic interest has focussed on the content of online discussion and on social network analysis (SNA): what is being said, and who is talking to whom (see e.g. de Laat et al., 2007).

Our analytic approach is somewhat different. SNA, and a number of other network mapping methods, are normally deployed to capture *emergent* phenomena in (learning) networks. Because we are particularly interested in design, we also need ways of identifying designed structures in learning networks, representing their salient qualities and also tracing connections between what has been designed and emergent activity. Like architects or urban geographers, we want to understand how 'built form' influences human activity.

For analytic purposes, we argue that it is valuable to study networked learning from at least two perspectives: (i) understanding the activity and experiences of participating individuals and (ii) understanding the qualities of the network itself. Neither of these, on its own, provides the insights necessary to inform good design.

Taking the participating individual's perspective makes it easier to understand how engagement in networked learning connects with the rest of a person's life.

Inspired by Ole Dreier's work on understanding everyday life, Jean Lave (2012) criticizes the

> common habits of limiting our research practice to one or two settings and looking at activity only within one setting at a time. [Dreier] insisted that *tracing persons' movements across the various contexts of their everyday lives* is necessary for understanding how participation changes in changing practice. (Lave, 2012, p. 162, emphasis added)

If we want to understand the *actual lived experience* of networked learning from the perspective of those most closely bound up in it we need to take into account *extensive* networks of various kinds of things. It is a profound mistake to restrict analysis to that which 'exists' in 'cyberspace' – to ignore the qualities of the place in which a person is physically located, the tools and resources which come to hand in that place, or their face-to-face interactions with colleagues, friends and family (Goodyear & Carvalho, 2013).

Learning networks cannot be understood, and design for learning networks cannot be informed solely by, the aggregated or averaged experiences of participating individuals. Learning networks have important qualities of their own, and not all of these are visible to network participants.

An analogy with urban architecture and planning helps make the point. The flows of people through city streets and squares can be modeled and predicted accurately from information about the morphology of the streets. This can be done independently of information about the starting points, goals and destinations of the individuals who are moving. There is a 'syntax of space' that can underpin such modeling, and predict both movement and the personal mental maps that people form as they navigate the city (Hillier, 1999; Zimring & Dalton, 2003; Long & Baran, 2012). We would argue that the practices involved in improving urban design are likely to fail if they neglect to tap, *or rely solely on*, the lived experiences of city dwellers. Similarly, analysing networked learning requires research into both (i) the activities, habitual practices and experiences of participating individuals and (ii) the structural qualities of networks themselves. What can be observed and measured at network level may be qualities that are 'designed in' *ab initio*, or may emerge during the life of the network, or (most often) are a mixture of both.

This interdependence of structures and individual action is crucial to understanding how learning networks function and evolve over time. Existing structures influence, but do not determine, the activities of people; the agency enjoyed by people is constrained, but rarely extinguished, by existing structures; over time, structures change in response to human action – they are built up, or worn down.[4]

Analysis and Design for Learning

The roles of analysis and design are not always well-articulated in recent writing on design for learning, yet their key relationships echo core concerns in both educational research and in the literature on (mainstream) design. In one of his most influential books, Bruner (1966) distinguished between descriptive theories of learning and prescriptive theories of instruction. The first analyses examples of learning, the second says what should be done to help people learn. In the mainstream design literature, Veermas and Dorst (2007) similarly talk about the tensions and ambiguities between description and prescription, going back decades into the very foundations of design methodologies.

Research on the art and science of design for learning necessarily recognises that some people, quite reasonably, take on responsibility for helping other people learn. Some of this responsibility is discharged through design. Its legitimacy depends, in part, on the legitimacy learners grant to designers and educators.

Analysis of learning networks provides descriptions of learning activity, and of the effects on learning activities of the situations in which it occurs. Reflection on these descriptions can produce ideas that designers may find useful. From an analytic perspective, we can investigate the entities involved in a network, their relations and boundaries in a way that is guided by the needs of design, for others. The analysis of learning networks can take a critical stance, but (in our view) 'analysis for design for learning' has to move beyond the critical, because of an ethical commitment to acting on behalf of learners – in part, to help people become more self-sufficient learners.

STRUCTURAL PROPERTIES OF LEARNING NETWORKS

When we analyse a learning network we focus on such things as the relationships between the people who are involved, the material environments in which they work or study, the digital and material tools and artefacts they are using, the activities which interest them and which hold them together. As we said earlier, such a heterogeneous network cannot easily be bounded. Rather, it is traced through links and nodes, with the analyst's attention drifting to local concentrations, or to distinctive or recurring configurations of elements.

The analyst wants to know what helps the network function – *what gives it life*. Analysis sometimes reveals that seemingly trivial details can be very important. It can simultaneously be the case that macro or high-level properties of the network are important. Sometimes, it is the alignment across scale levels that matters. For example, from very early studies in this field we know that the availability or absence of certain kinds of communicative tools can have powerful effects on the communication that does or does not happen. The choice to use email rather than an online discussion board can threaten to extinguish certain kinds of valued activities, such as sustained discussions (Goodyear & Steeples, 1992; Tagg, 1992).

Analysis that can inform the practices of design for learning networks therefore needs to have methods for making sense of a wide variety of entities and their relationships. This includes methods from such areas as computer-interface design, information architecture, ergonomics and usability, learning needs analysis, pedagogy, cognitive and motivational psychology, and more. It is easy to get lost in the miscellany of methods and theories prevailing in these areas.

A complementary way of approaching the analysis of learning networks is to try to capture higher-level qualities that are shared by many examples of lively, active, productive networks. It is important to then be able to render these in ways which can actually inform the work of designers – not to stop at the level of vague abstractions or exhortations (e.g. 'keep the learners engaged').

We have been using Christopher Alexander's work on design patterns and pattern languages (Alexander, 1979; Alexander et al., 1977) for some time now (see e.g. Goodyear, 2005; Goodyear et al., 2004; Goodyear & Retalis, 2010). In our recent analytic work, we have been taking inspiration from Alexander's exploration of the 'fundamental properties' which he says appear again and again in things which have life (Alexander, 2006, Vol1, esp. pp. 144–296). We are not alone among educational researchers in taking this step in the journey (see e.g. Bauer & Baumgartner, 2010). However, we think we are succeeding in finding some particularly useful links between Alexander's thoughts and the properties of learning networks.

Alexander, Analysis and Design

Part of the appeal of Alexander's early work on design patterns arises from the way he conjures up images of convivial urban, working and domestic life, and from the architectural sensibility that allows him to relate human experience, activity and emotion to the qualities of the material world. Like most designers, he has a commitment to improving life through action in the material world. Unusually, he works across vast distances in scale and scope (from ornaments to geographical regions). His invention of the *pattern language*, which aligns designed elements across scale levels to meet the needs of a project, resonates nicely with the problems of design for learning, wherein we know that influential factors range across scales from 'neurons to neighborhoods' (IOM/NRC, 2012). Similarly, design for learning needs to be able to help align designed (and other) elements across scale levels.

Design is a way of balancing competing forces – of reconciling incompatible requirements, sometimes by reframing the situation so that the proposed solution meets deeper needs. For example, a theme running through Alexander's work is the need to design for the diverse wishes of autonomous individuals *and* for conviviality. His analysis of built forms – especially rooms, the transitional spaces around homes, and urban spaces – shows how privacy and community can be afforded simultaneously in good designs. The rest of this chapter provides two examples where we have drawn on Alexander's writing to guide our thinking about the analysis of learning networks.

First Example: Strong Centres

As our first example, we take a major theme of Alexander's 2006 book *The nature of order*. Alexander's analysis is concerned with identifying the commonalities between forms that he describes as having 'more life' or 'greater wholeness' than similar forms which he, and other people in empirical studies, find less alive or whole.[5] The early parts of his analysis, on which we draw, are primarily concerned with the qualities of artefacts and buildings. He identifies 15 fundamental properties (structural features) that he finds, in various combinations, in things that have 'more life'. These properties mostly pertain to visual perception – that is, they capture qualities that can be seen, such as levels of scale in the façade of a building, boundaries, local symmetries, deeply interlocking forms, etc. While visual perception is very salient here, Alexander is deeply concerned with other senses (especially touch) but, more importantly, he is concerned with how the structural properties of the place or artefact affect how we feel; how good we feel in its presence.

As we pointed out earlier, it is hard to find an exact boundary to a learning network. The essence of the network – what it is, for most of its participants – lies closer to its core than its margins. How does one find the centre (or centres) of a network, either as a participant or analyst? One traces participants' activity and finds the places where the discussions are most active, the links thickest, the talk most on-topic, the sharing most reciprocal. These are the places where the network is most alive, towards which people will gravitate and in which they are most likely to linger. Alexander speaks of 'strong centres' and indeed sees them as the most profound of the 15 properties. He describes how they appear and function in a variety of artefacts (like carpets and ceramics) and in buildings and more complex urban forms. He finds them more often in older, craft-based, objects and buildings than in the modern or mass-produced. Here, he illustrates the idea with an example from China:

> The imperial inner city of Beijing has a centered quality. It is a layered system of nested domains which lead, one by one, to the inner city, and then to the inner sanctum of the inner city. The hierarchy of layers creates the deep feeling and intensity of the center: the deep center arises at the heart of the inner city, because of the field effect generated by the nesting. We pass through a series of zones of increasing intensity as we go into the building: the gradient of increasing intensity creates a center… (Alexander, 2006, p. 154–5)

And he contrasts this with the difficulty of finding strong centres in much of modern architecture, including modern western homes, where neither the fire, nor the kitchen, the TV or the bed are important enough to carry the role.

Within learning networks, we can sometimes see how patterns of activity point to where we might find a strong centre. Indeed, a peculiar characteristic of learning networks is that participant activity furnishes and indeed reshapes the landscape. An over-literal example is in shared virtual worlds, such as Second Life, where participants build, decorate and visit. But even in older spaces, such as with asynchronous discussion boards, the landscapes through which one navigates are partly formed from sedimented conversations.

Analysis of learning networks sometimes reveals silent, abandoned places. Sometimes it reveals intense activity. What is found, through such analysis, is of course a mix of original designed space and the traces of subsequent activity. If strong centres can be created and reinforced, in the original design, then one has reason to hope that activity will follow – that in their online work, people will gravitate towards places where it feels good to linger, and through their online activity will further furnish and add patina to the places where they feel most themselves.

In learning networks, then, how do we recognise such strong centres? And what do we need to know in order to help create them?

Our best guess is that something akin to Alexander's visual sensibility is analytically useful. This is partly because the dominant ways of interacting with and through an online learning network involve the visual. Most, if not all, of what we need to know, in order to navigate online, works in the visual mode.[6] And apart from the special case of 3-D virtual worlds, our navigation is dependent on visual information that is organised in the 2-D plane of the computer screen. Alexander's examples of strong centres in built space assume an ability to move *through* space – to see as a person moving, rather than as a static observer. The strong centres he described in his example from Beijing really only work if one is passing through/into the spaces concerned. Is there an analogue in the 2-D plane that provides the interface to most online learning networks? How can screen layout help create strong centres?

At a minimum, this must mean that the screens/pages on which people most rely to help them navigate should give some clues about where life is to be found – drawing one towards the centres of current or recent activity. If there is a variety of such places, then visual clues that nudge one this way or that (depending on current interest or mood) would be helpful.[7] Of course, some normal rules of interface design apply: that one should not be forced to read detailed instructions, overdose on information, or have to think too hard about where to head – signs or sounds should beckon and suggest, leaving one's scarce mental resources free for the more demanding work of engaging in intelligent conversation (see also Long & Baran, 2012 on the 'legibility' of built space).

The allusion to Second Life, above, raises questions about how long our 2-D interfaces will continue to provide the principal mode of interaction. Anyone thinking about the future of design for learning (and its analytic counterpart) is bound to wonder what may change, and what certainties will be shaken, when immersion in a virtual world, with speech and haptic interaction, becomes more common (Kirsh, 2013). Such thinking also needs to recognise that our immersion into the virtual world has a counterpart – as the digital infiltrates the material world (with mobile personal devices, tangibles, programmable objects, ambient intelligence, etc). In one way, this accelerating inter-penetration of the virtual and material worlds (Mitchell, 2003) simplifies the relations between Alexander's work and our own. When there ceases to be a sharp distinction between the virtual and the material, then design and analysis can operate more uniformly, albeit across heterogeneous networks.

Second Example: Rapid Urbanisation and the MOOC Phenomenon

Networked learning is getting more attention right now than it has for a decade or so – the main reason being that staff associated with a number of prestigious universities are offering so-called MOOCs – Massive Open Online Courses (OBHE, 2012; Kay et al., 2013). Anyone summarising the central tendencies in the networked learning literature till recently might well have come to the view that learning networks in formal education involve rather small numbers of learners (tens to small numbers of hundreds) to which the design metaphor of the 'virtual classroom' might fairly be applied. Associated design elements include such things as a 'virtual café' (where learners can discuss whatever they wish to discuss, not just matters relating directly to a course), and 'notice boards', where important announcements can be posted. The scale is cosy and bijou, if a little self-conscious and awkward.

Networked learning design elements that work (reasonably well) at such small scale are suddenly challenged by the MOOC phenomenon – rather as if the hamlet had become a town of 100,000 people, without much consideration of the need for new kinds of building or infrastructure. What options are there for aligning designed elements to the needs of a town rather than a village? On one view, MOOCs pretty much ignore the social. The core idea in such a design is that an expert lecturer makes available videos of themselves presenting mini-lectures, and learners watch and listen. There need be no social organisation, beyond distinguishing the lecturer from the student, the preacher from the congregation, or the rock star from the audience. At one level up, in the design/evolutionary chain, students can be allocated to small study groups – either on a random or algorithmic basis. When they work well, these groups can help with peer feedback and various kinds of study support. But they are often just a cloning of the virtual classroom – tens or hundreds of identical rooms, with students allocated to rooms (not necessarily to groups) on an arbitrary basis. A less managerialist approach would let students pick their own groups – but if the rooms are all the same, and the information about group members is sketchy, what kind of choice is this? One is either a prisoner, or lost in the city. A cyber-urban *anomie*, as much as wishful thinking at enrolment time, might explain the high disengagement rates found in many MOOCs.

How might this be done better? What kinds of ideas and experiences, what analytic and design constructs could help, when thinking about the 'rapid urbanisation' that MOOCs represent?

Alexander writes a lot about convivial life in towns and cities (see especially the first half of *A Pattern Language*). His ways of analysing what works in convivial, human, *lively* urban spaces, make it easy to spot what is missing with the identical, cloned spaces of a MOOC. One might say he is at his best when he is analysing the success of small public squares, street cafes, beer halls, self-governing workshops, food stands and bus stops. He can explain why different activities cluster together, at what spatial intervals, and how people gravitate to places that make them feel good. From this, he can generate design constraints that help with the creation or repair of living spaces – such as by limiting the height of buildings in which people are to live (four floors), or the amount of land zoned for parking (<9%), or the minimum distance between corner grocery stores (200 yards). He also writes about the two opposite ways in which built form can supress human social activity – by imposing structural form so that social activity has to adjust to its needs, or by offering so little structure that social activity feels it has lost its place (Alexander et al., 1977, p. 941–5). Space that is too rigid *or* too flexible can be damaging (cf. Boys, 2011).

In an early, highly regarded paper on problems in the planning of new cities, Alexander (1966) observed a crucial difference between organically-developing ('natural') cities and many of those 'artificial' cities being constructed to the designs of urban planners. Looking more deeply into the structural differences, he discerned that the new designs commonly made use of simplifying strategies (a 'compulsive desire for neatness and order') that resulted in sharply segregated uses for space. In contrast, many of the spaces in organically-developing cities typically involve the overlap of several different systems of activity, giving depth and richness and also mutually-reinforcing patterns that help each area of activity prosper. (One of his examples is of how urban zoning regulations, intended to separate residential and industrial activities, make it hard for small (home-based) businesses to start up.)

What has this to do with MOOCs? Some of the more innovative possibilities being explored by MOOC platform developers include a combination of learning analytics and artificially-intelligent agents to provide more targeted pedagogical support for learners (see e.g. Kay et al., 2013; Daradoumis et al., 2013). The logic behind this is one which foregrounds *teaching*. In contrast, or in addition, one might choose to foreground *space* – to think about ways of enhancing the experience of MOOCs that resonate with ways we experience the buzz of a vibrant city. After all, MOOCs bring together thousands of people with shared interests and diverse backgrounds. The simplifying tendency identified by Alexander would be reflected in MOOC providers using learning analytics data to cluster people together around shared profiles – 'the mania every simple-minded person has for putting things with the same name into the same basket' (Alexander, 1966, p. 13). It might be better to use intelligent software to generate online spaces within each of which several activity systems, of interest to diverse groups of people, overlap (Alexander, 1999). For the technically-minded, production of such spaces needs to be guided by the creation of semi-lattice, rather than tree-like, forms.

> It must be emphasised, lest the orderly mind shrink in horror from anything that is not clearly articulated and categorised in tree form, that the ideas of overlap, ambiguity, multiplicity of aspect, and the semi-lattice, are not less orderly than the rigid tree, but more so. They represent a thicker, tougher, more subtle and more complex view of structure. (op. cit., p. 9–10)

MOOCs are not necessarily privatizing; their use does not have to entail individualized and isolated learning experiences. Indeed, the earliest MOOCs (cMOOCs rather than xMOOCs) had a strong, collaborative, community-oriented design philosophy (Clarà & Barberà, 2013). Some recent work with xMOOCs at the Ecole Polytechnic Federale de Lausanne has been experimenting with complementary, face-to-face study groups (Li et al., 2014).

The insight we take from Alexander's work is that the generation of spaces suited to more convivial interactions in and around MOOCs would be (a) worthwhile, (b) best approached in terms of helping people find the kinds of places and activity bundles in which they would like to engage, rather than simply trying to find like-minded others. Such evidence as we have in the still rather scant MOOCs literature suggests that participation in collaborative activities in cMOOCs is not necessarily straightforward (Mackness et al., 2010), and that some structuring resources (such as 'legible places') might be very helpful to people who are struggling to organize their work. And while the face-to-face study groups investigated in the EPFL research (Li et al., 2014) seem to be a useful complement to online lectures, they are not straightforwardly replicable or scalable outside a formal education context. Alexander's influence on our design imagination is not of a kind that can quickly specify solutions for some of the issues being experienced with MOOCs. Instead, it helps us see that there might be more creative ways of thinking about large-scale online learning: not so much a global classroom as a learning city.

CONCLUDING COMMENTS

In this chapter, we have tried to show how the judicious translation of some ideas about built form, derived mainly from the work of Christopher Alexander, can guide the analysis of learning networks, and especially of the designed structures they can inhabit. We see three lines of connection between these ideas and their application in the analysis of structures in networked learning. First, there is what we referred to as the *literal-virtual* connection – such as when networked learning is housed in Second Life. Then there is the *emerging-hybrid* connection – where we stop seeing the virtual and material worlds as separate, and think more carefully about designs that help integrate activity across increasingly complex and heterogeneous spaces. Thirdly, there is a more *metaphorical* connection, in which our understanding of how people perceive and navigate in built space can be translated and used to design interfaces to virtual spaces. For example, we might argue that many of the spaces inhabited by today's learning networks are so structurally simple and lacking in texture that they stimulate only a very narrow range of activities and interactions. To this we might add that the navigation of more complex spaces is overly dependent on maps and signposts – on texts rather than visual cues – such that the poor legibility of online spaces limits the design imagination.

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NOTES

1 The main ideas and educational practices associated with networked learning go back to the 1970s, if not earlier. Ivan Illich's provocative writings about 'learning webs' are often cited as an early source. They contain some striking thoughts about repurposing some emerging technologies (see e.g. Illich, 1971, p. 75 ff.). Alexander draws on Illich's ideas in describing his 'Network of Learning' design pattern (Alexander et al., 1977, p. 99–103). The wave of writing based on early experiments with 'computer-mediated communication' (CMC) in the late 1980s is also worth consulting for some foundational ideas (see e.g. Mason & Kaye, 1989; Riel & Levin, 1990; Kaye, 1992). See also early writing on network technologies for collaboration in business such as Schrage (1990).

2 Jean Lave remarks on 'the commonplace ways in which we too easily collapse "learning" into "acquisition of knowledge," as a decontextualized end in itself. When we take a relational perspective, "knowledge" or "knowledge-ability" must be understood as part of, and as taking meaning from and for, persons engaged as apprentices to their own changing practice across the multiple contexts of their lives' (Lave, 2012, p. 167). (Cf. Ingold who speaks of learning as improvising movement along a way of life.)

3 Much of the early literature on networked learning was written by university-based teachers who were pioneering such approaches. Their educational philosophies and pedagogical approaches were often inspired by ideas that did not sit comfortably with prevailing notions of how formal higher education should be done. The resulting literature sometimes underplays the shaping effects of university rules and power relations on students' activity.

4 The same is true of a very wide variety of human activity (Giddens, 1984). John Law expands on the point in relation to analyzing networks: "… it is necessarily important to distinguish people from artefact … such objects are understood as being shaped by humans. And in turn they produce a context, a geography or an architecture which enables and/or constrains subsequent human projects. … entities, things, people, are not fixed. Nothing that enters into relations has fixed significance or attributes in and of itself. Instead, the attributes of any particular element in the system, any particular node in the network, are entirely defined in relation to other elements in the system, to other nodes in the network. And it is the analyst's job, at least in part, to explore how those relations – and so the entities that they constitute – are brought into being" (Law 2006).

5 For another example of our analysis, along these lines, see Thompson & Kelly (2012)

6 There have been some interesting experiments with 3-D audio in virtual worlds which could be interesting to pursue here.

7 The increasingly common use of more complex and/or subtle forms of navigation control, such as through touch pads, touch screens, multi-touch tables, kinect sensors etc., means that the design issue is not so strongly related to visual perception. We imagine that visual cues to trigger more complex touch/gestural navigational moves will become the norm.

REFERENCES

Alexander, C. (1966). A city is not a tree. *Design*, 126.

Alexander, C. (1979). *The timeless way of building,* New York, NY: Oxford University Press.

Alexander, C. (1999). The origins of pattern theory: The future of the theory and the generation of a living world. *IEEE Software*, *16*, 71–82.

Alexander, C. (2006). *The nature of order*. Berkeley, CA: Center for Environmental Structure.

Alexander, C., Ishikawa, S., Silverstein, M., Jacobson, M., Fiksdahl-King, I., & Angel, S. (1977). *A pattern language: towns, buildings, construction*. New York, NY: Oxford University Press.

Barabási, A. L. (2002). *Linked: The new science of networks*. Cambridge, MA: Perseus Publishing.
Bauer, R., & Baumgartner, P. (2010). *The potential of Christopher Alexander's theory and practice of wholeness: Clues for developing an educational taxonomy*. EuroPLoP '10 Proceedings of the 15th European Conference on Pattern Languages of Programs.
Borgatti, S., & Foster, P. (2003). The network paradigm in organizational research: A review and typology. *Journal of Management*, *29*, 991–1013.
Boys, J. (2011). *Towards creative learning spaces: Re-thinking the architecture of post-compulsory education,* New York, NY: Routledge.
Carvalho, L., & Goodyear P., (Eds.), (2014). *The architecture of productive learning networks.* New York, NY: Routledge.
Castells, M. (1996). *The rise of the network society,* Oxford: Blackwell.
Clarà, M., & Barberà, E. (2013). Learning online: Massive open online courses (MOOCs), connectivism, and cultural psychology. *Distance Education*, *34*(1), 129–136.
Daradoumis, T., Bassi, R., Xhafa, F., & Caballe, S. (2013). *A review on massive e-learning (MOOC) design, delivery and assessment*. Eighth International Conference on P2P, Parallel, Grid, Cloud and Internet Computing (3PGCIC), 208–213. doi: 10.1109/3PGCIC.2013.37
de Laat, M., Lally, V., Lipponen, L., & Simons, R. J. (2007). Online teaching in networked learning communities: A multi-method approach to studying the role of the teacher. *Instructional Science*, *35*, 257–286.
Fenwick, T., Edwards, R., & Sawchuk, P. (2011). *Emerging approaches to educational research: Tracing the sociomaterial*. Abingdon: Routledge.
Gee, J. (2005). Semiotic social spaces and affinity spaces: From the age of mythology to today's schools. In D. Barton & K. Tusting (Eds.), *Beyond communities of practice: Language, power and social contex*t. Cambridge, UK, Cambridge University Press.
Giddens, A. (1984). *The constitution of society: Outline of the theory of structuration*. Berkeley, CA, University of California Press.
Goodyear, P. (2002). Online learning and teaching in the arts and humanities: Reflecting on purposes and design. In E. A. Chambers & K. Lack (Eds.), *Online conferencing in the arts and humanities* (pp. 1–15). Milton, Keynes: Institute of Educational Technology, Open University.
Goodyear, P. (2005). Educational design and networked learning: patterns, pattern languages and design practice. *Australasian Journal of Educational Technology*, *21*, 82–101.
Goodyear, P., & Carvalho, L. (2013, September). The analysis of complex learning environments. In H. Beetham & R. Sharpe (Eds.), *Rethinking pedagogy for a digital age: Designing and delivering e-learning*. New York,NY: Routledge.
Goodyear, P., & Dimitriadis, Y. (2013). In medias res: Reframing design for learning. *Research in Learning Technology, 21*.
Goodyear, P., & Steeples, C. (1992). IT-based open learning: Tasks and tools. *Journal of Computer Assisted Learning, 8*(3)*,* 163–176.
Goodyear, P., Banks S., Hodgson V., & McConnell D. (Eds.). (2004a). *Advances in research on networked learning*. Dordrecht,The Netherlands: Kluwer Academic Publishers.
Goodyear, P., Avgeriou, P., Baggetun, R., Bartoluzzi, S., Retalis, S., Ronteltap, F., & Rusman, E. (2004b), Towards a pattern language for networked learning. In S. Banks, P. Goodyear, V. Hodgson, C. Jones, V. Lally, D. McConnell, & C. Steeples, (Eds.), *Networked learning 2004.* Lancaster: Lancaster University.
Granovetter, M. (1983). The strength of weak ties: A network theory revisited. *Sociological Theory*, *1*, 201–233.
Haggett, P., & Chorley, R. J. (1969). *Network analysis in geography*. London, UK: Edward Arnold.
Harasim, L., Hiltz, S., Teles, L., & Turoff, M. (1997). *Learning networks: A field guide to learning and teaching online*. Cambridge, MA: MIT Press.
Hillier, B. (1999). *Space is the machine: A configurational theory of architecture*. Cambridge, UK: Cambridge University Press.
Hutchins, E. (2010). Cognitive ecology. *Topics in Cognitive Science*, *2*, 705–715.
Illich, I. (1971). *Deschooling society*. New York, NY: Harper Row.

IOM (Institute of Medicine) and NRC (National Research Council) (2012). *From neurons to neighborhoods: An update: Workshop summary*. Washington, DC: The National Academies Press.
Jones, C. (2004). Networks and learning: Communities, practices and the metaphor of networks. *ALT-J*, *12*, 81–93.
Kay, J., Reimann, P., Deibold, E., & Kummerfeld, B. (2013). MOOCs: So many learners, so much potential. *IEEE Intelligent Systems*, *28*(3), 70–77.
Kaye, A. (Ed.). (1992). *Collaborative learning through computer conferencing: The Najaden papers*. Berlin, Germany: Springer Verlag.
Kirsh, D. (2013). Embodied cognition and the magical future of interaction design. *ACM Transactions on Computer-Human Interaction*, *20*, 1–30.
Knappett, C. (Ed.). (2013). *Network analysis in archaeology: New approaches to regional interaction*, Oxford, UK: Oxford University Press.
Lave, J. (2012). Changing practice. *Mind, Culture, and Activity*, *19*, 156–171.
Law, J. (2006). Networks, relations, cyborgs: On the social study of technology. In S. Read & C. Pinilla (Eds.), *Visualizing the invisible: Towards an urban space.* Amsterdam, The Netherlands: Techne Press.
Li, N., Verma, H., Skevi, A., Zufferey, G., & Dillenbourg, P. (2014). MOOC learning in spontaneous study groups: Does synchronously watching videos make a difference? European MOOCs Conference. Retrieved from http://infoscience.epfl.ch/record/196608/files/nanli_submission%20(Last%20Version).pdf
Long, Y., & Baran, P. K. (2012). Does intelligibility affect place legibility? Understanding the relationship between objective and subjective evaluations of the urban environment. *Environment and Behavior*, *44*, 616–640.
Mackness, J., Mak, S. & Williams, R. (2010). The ideals and reality of participating in a MOOC. Networked learning conference. Lancaster, UK: University of Lancaster.
Mason R., & Kaye A., (Eds.), (1989). *Mindweave: Communication, computers and distance education*, Oxford, UK: Pergamon.
Mitchell, W. J. (2003). *Me++: The cyborg self and the networked city.* Cambridge, MA: MIT Press.
Observatory on Borderless Higher Education. (2012, October). MOOCs and disruptive innovation: The challenge to HE business models. Retrieved from http://www.obhe.ac.uk/documents/view_details?id=929
Pinto, A. (2014). *Design and the functioning of a productive learning network*. 9th International Conference on Networked Learning 2014, Edinburgh: Networked Learning Conference Organiser.
Podolny, J., & Page, K. (1998). Network forms of organization. *Annual Review of Sociology*, *24*, 57–76.
Riel, M. M., & Levin, J. A. (1990). Building electronic communities: Success and failure in computer networking. *Instructional Science*, *19*, 145–169.
Schrage, M. (1990). *Shared minds: The new technologies of collaboration.* New York, NY: Random House.
Steeples C., & Jones C. (Eds.). (2002). *Networked learning: Perspectives and issues*. London, UK: Springer.
Tagg, A. (1992). *Computer conferencing systems and their application: A suggested methodology*. London: Birkbeck College, University of London.
Thompson, K., & Kelly, N. (2012). *Combining collaboration spaces: Identifying patterns of tool use for decision-making in a networked learning environment*. 8th International Conference on Networked Learning, Maastricht, Netherlands.
Wenger, E., Trayner, B., & de Laat, M. (2011). *Promoting and assessing value creation in communities and networks: A conceptual framework*. Heerlen, Netherlands: Ruud de Moor Centrum, Open Universiteit of the Netherlands.
Zimring, C., & Dalton, R. C. (2003). Linking objective measures of space to cognition and action. *Environment and Behavior*, *35*, 3–16.

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3. CONCRETIZATION OF DESIGN IDEAS IN THE CONTEXT OF EDUCATIONAL TECHNOLOGY DESIGN

INTRODUCTION

Research in the learning sciences has shown that many opportunities to learn arise in the course of designing an artefact in general, and in designing an artefact intended for others to learn with, in particular. Papert (1991), in his description of constructionism claimed that a productive way to support learning is to engage learners in constructing a public artefact "whether sand castle on the beach or a theory of the universe" (p. 1).

The potential of designing as a process that supports student learning has been documented for a wide range of ages, contents, contexts, and levels of expertise, such as elementary school mathematics and basic programming (Harel, 1991; Kafai, 2006), and middle school science (Kolodner et al., 2003). In recent years, learning by design as a pedagogical approach has also been studied in the context of teacher learning and professional development, in which the process of design (and especially collaborative design) of curriculum materials showed to hold much promise for teachers learning (Bannan-Ritland, 2008; Kali, McKenney, & Sagy, 2015; McKenney & Voogt, 2012; Voogt et al., 2011; Voogt et al., 2012). However, as stated by Voogt et al., (2012). "while it is assumed that the activities teachers undertake during (re-)design of curriculum materials can be beneficial, few studies involving teachers (re-)designing curriculum design measure more than effects of this activity on teacher attitudes, the quality of the designed artefacts, and/or implementation of the curriculum innovation at hand." (p. 1). In this research we focused on a particular aspect in teachers' learning by design process, which, as we explain later, came up during our design-based research with graduate students in education who participated in a technology-enhanced curriculum design course. These students (who were also teachers in various educational contexts), while learning to design technology-enhanced curriculum modules, struggled with what we characterized as "concretization" of their design ideas. We begin by providing a brief theoretical background on which we based our pedagogical approach in the design course, borrowing lessons learned from other design fields, such as architecture. We then describe the pedagogical model we developed for teaching technology-enhanced curriculum design that is based on well-established design principles

M. Maina et al. (Eds.), The Art & Science of Learning Design, 31–47.

(Kali & Ronen-Fuhrmann, 2011). The heart of this chapter then follows, focusing on the design-based research in which we examined how students developed the skill to concretize their design ideas.

BACKGROUND

Schon (1983) showed that when expert architects make design decisions they rely heavily on their tacit knowledge, which he referred to as design knowledge. He studied how expert architects share their design knowledge with novices in a design studio, and showed that reflective conversations in the design studio play a crucial role in students' capability to gain design knowledge. The learning processes and teaching techniques in the design studio have since been studied quite substantially by researchers in architecture education (e.g., Goldschmidt, 2002). Recently, it has been adopted as a pedagogical approach in the field of educational technology design as well (Cox et al. 2008; Green & Bonollo, 2003; Hoadley & Kim, 2003; Mor & Mogilevsky, 2013a; Mor & Mogilevsky, 2013b; Shaffer, 2002). However, the processes in which students in education develop their design knowledge still require more research. Specifically, a phenomenon that has been well-documented regarding such processes with a different audience—novice instructional designers (who do not necessarily have an education background)—showed that they have a tendency to jump prematurely to design solutions (or concretization of design ideas), without deeply exploring the pedagogical rationales behind them (Ertmer et al., 2009; Kerr, 1983; Rowland, 1992). In this research we sought to examine the role of concretization in the learning processes of graduate students in education.

In the past decades, much design knowledge has been gained by expert educational technology designers, and accumulated via design research projects. Researchers have sought various ways to make this knowledge available and useful for other educational technology designers, and particularly for novices in this field. In such fields generalizations of common examples are often articulated, to enable their application in other settings. Following the work of Alexander (1979), and his vision for articulating a "design pattern language" in architecture, researchers have developed several ways in which to articulate general design guideline for curricular design. Three substantial types of guidelines that have been developed are: (a) design narratives (Hoadley, 2002; Mor & Noss, 2008), (b) design principles (Herrington, 2006; Kali, 2006; Linn, Bell, & Davis, 2004; Merrill, 2002; Quintana et al., 2004; van den Akker, 1999), and (c) design patterns (Goodyear, 2005; Linn & Eylon, 2006; Mor & Winters, 2007; Retalis, Georgiakakis, & Dimitriadis, 2006).

Unfortunately, efforts to translate expert tacit knowledge into practical design guidelines have often failed to serve as useful aids for novice designers (McAndrew & Goodyear, 2007). It appears that in order for novices to take advantage of such guidelines, a pedagogical framework is required. To overcome this challenge, we developed, in a previous study (Kali & Ronen-Fuhrmann, 2011), a pedagogical model aimed at assisting graduate students in education to design technology-enhanced curriculum modules. Three main constructs of this model were the utilization of: (a) the well-known ADDIE stages (Gustafson & Branch, 1997), (b) the studio approach, and (c) a public online repository of empirically-based design guidelines, called the Design Principles Database (DPD) (Kali, 2006). The model was developed in a designed-based research methodology with three iterations. For each one of the iterations, we designed a course that was based on the pedagogical model and was implemented with students. Data from each iteration were analyzed, and design decisions were made to improve the model for the next iteration. The two authors of this paper served as the instructors of the course in the three implementations (as often the case in design-based research projects).

The pedagogical model (Figure 1) was embedded in a design course which combined theoretical and practical aspects of educational technology design, with the aim of supporting the practical aspect of the design (Kali & Ronen-Fuhrmann, 2011).

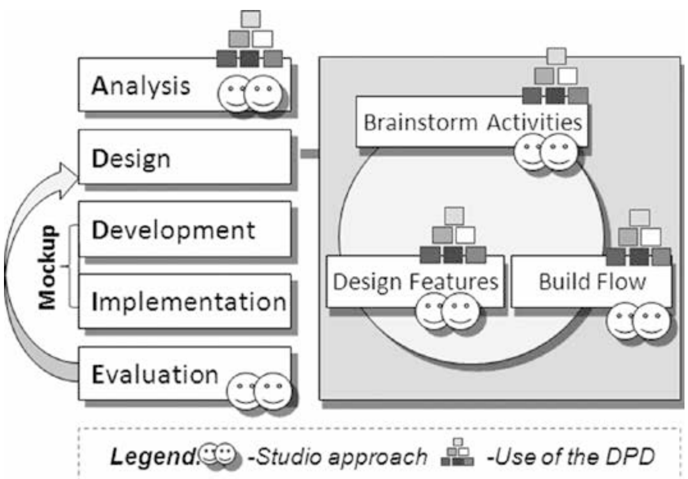

Figure 1. The pedagogical model: Application and integration of the ADDIE stages, the studio approach and the use of the DPD (Ronen-Fuhrmann & Kali, 2011)

Research Goal

One of the outcomes of the Kali and Ronen Fuhrmann (2011) research showed that in the technology-enhanced educational modules they designed, students tended to stay at an abstract level and had a difficulty to translate their pedagogical rationales and design ideas into concrete features. Thus, by the end of the course many artefacts stayed at an immature level. The goal of the current research was to explore the nature of this difficulty, as well as to examine whether the refinements made in the pedagogical model in the three iterations better supported students to overcome this challenge of concretizing their design ideas.

Table 1 provides a summary of the design decisions we made in the iterations of the previous study, which eventually brought to the development of this pedagogical model.

		Challenging outcomes	*Design decisions*	*Description of the pedagogical model*
Pilot	1	Students had difficulties due to the open-ended nature of task	Structure the design process	The course was initially conducted as a one-on-one project. Individual students were guided by us, the teachers, through occasional non-structured meetings. Due to requests from the students (N=4), this was changed during the pilot, to include class meetings every other week. The meetings at this stage did not have a pre-defined structure; students presented their progress and their emerging challenges, while the other students and mentors (us) provided feedback.
	2	Many students were unaware to rationale behind features they designed	Use the DPD to emphasize awareness to rationale	
	3	Students made design decisions, based on limited intuition	Enrich students' intuition by integrating the pedagogical model in a design course	
	4	Students had little confidence in designing	Employ a cognitive apprenticeship model (gradual fading of guidance)	
	5	Peer learning needed strengthening	Add collaborative aspects to the model	
Iteration-I	6	Students tended to build flow of activities according to hierarchy of contents (rather than on making learning interesting)	Add a content analysis stage early in the design process	A first version of the pedagogical model was developed and included the ADDIE structure and the use of the DPD. A cognitive apprenticeship pedagogical approach was employed, and collaborative aspects were added. In this iteration we still did not employ a content analysis stage, and only design cycle was conducted.
	7	Students were frustrated from inability to implement feedback	Add a second design cycle	
Iteration-II	8	Online peer assessment was not sufficient	Add face-to-face dialogic critique sessions between groups	The pedagogical model was implemented as in the previous iteration except that now a content analysis stage was employed early in the design process, and a second design cycle was added. Students still worked with two online learning environments: a LMS in which all instructions were provided, as well as the DPD in which the design guidelines were provided.
	9	Students were confused due to the two infrastructures used	Embed the entire pedagogical model into the DPD	
Iteration-III		None	None	The final version of the model was implemented, in which all design decisions from former iterations were implemented.

METHODOLOGY

As students progressed in their design process in the course, they were required to submit six artefacts, each with a greater amount of detail (and ideas moving on a path from abstract to concrete), and a higher degree of maturity. In their final artefact, they were required to depict a full learning environment with a clear navigation scheme illustrating a sequence of activities with clear instructions for learners. However, as mentioned above, many students had difficulty reaching this degree of maturity and concretization in their design artefacts.

Our analysis was twofold: (a) In order to explore the nature of this difficulty, we used a collective case study approach–often referred to as "multiple case study" (Stake, 1994). This approach is aimed at providing insights into an issue or problem or to refine a theory by exploring similarities and patterns between several case studies. In this research, students worked in groups of two or three. Each group was defined as a case; (b) To compare between the artefacts designed by the groups in the three iterations, we built a "Maturity Of Design Artefact (MODA)" rubric that corresponds to the six stages of the design requirements in the course. We used the MODA rubric to analyze student artefacts, as we explain in the data analysis section below.

Research Participants

From the data gathered in Kali and Ronen-Fuhrmann (2011), a sub-sample of 33 students, who worked in 14 groups, was chosen for the current analysis: 11 students (4 groups) in iteration 1, 8 students (4 groups) in iteration 2, and 14 students (6 groups) in iteration 3. The rationale for focusing on these 14 case-studies was that students in these cases had a similar background, which enabled us to compare between the three iterations. All participants in this subset were graduate students in science education who participated in the course in three successive years at one university. Most of the students had a good background in theory regarding learning and teaching. Most of them also had some practical experience in teaching or were active science teachers, and some were also involved in development of curriculum materials that were not enhanced by technology. However, for all students, this course was their first educational technology design course. The modules they chose to design were typically in science, math and computer science.

Data Sources

To analyze student learning processes, we used: (a) reflective essays that students were asked to write at the end of the course, (b) semi-structured interviews with 6 students (two from each iteration), (c) records of online discussions (whole class discussions about the literature and group discussions regarding the design process), (d) design artefacts (formal artefacts produced at various stages of the course, as well as informal notes and sketches they created to discuss their ideas), and (e) notes from our reflective journal.

Data Analysis

Assessing students' design artefacts. To assess the design artefacts of the 14 case-study groups we first created digital portfolios for each group. Each portfolio included all in-progress and final documents created by the group, all posts in the course's discussion forum, posted by the individual students in the group, transcriptions of their interviews, and their reflective essays. We then articulated an initial version of the MODA rubric, based on the degree of maturity of design artefacts required in the six stages of the course. To refine this initial version of the rubric, we took one example case-study, and had four researchers—two external researchers and the two authors of this paper—assess the degree of maturity of design artefacts of that group at each stage of the design process. Initially, about a 60% agreement was reached. Following several cycles of refinement of the rubric, in which more case studies were assessed, we reached a degree of 90% agreement between researchers using the current version of the MODA rubric (Table 2). In this manner seven of the portfolios (50% of the cases) were assessed. The rest of the case-studies were then assessed by the authors of this paper together (without comparison of individual assessments). It is important to note that the MODA rubric was developed to help us understand why students encountered the difficulty of translating their design ideas into concrete features in the learning environments they designed. However, the MODA rubric does not enable to evaluate the quality of the design ideas themselves.

Table 2. Maturity of Design Artefact (MODA) rubric

Stage in Design Process	*Degree of Maturity Required in the Design Artefact**	*Representative Artefacts or Expressions*
Analysis	Only general pedagogical ideas about the module should be expressed in this stage	"It's very important to build activities that would be relevant and interesting to the learner" (Except from a discussion of one of the groups in the analysis stage)
Brainstorm Activities	A collection of design ideas for the module. The ideas should only generally refer to the way a learner might act in the module.	"Learning throughout the whole module should follow a specific inquiry question". (Excerpt from a discussion of one of the groups regarding their design of a biology module. They planned to design the activities around an inquiry question but were not concerned at this stage about the nature of this question).

Table 2. (Continued)

Stage in Design Process	*Degree of Maturity Required in the Design Artefact**	*Representative Artefacts or Expressions*
Build Flow	Graphical or verbal description of a set of activities, with an indication of which activity should take place before or after another.	"First we should show them [the learners] the story about the family tree, then have them review the algorithm for scanning the tree, and then use the simulation" (Excerpt from a discussion regarding the design of a module for high-school computer-science learners)
Design Features	Ideas should be translated to actual features and presented in a way that shows how a learner might interact with the module.	Figure 2a shows a sketch of the way students envisioned an activity they planned for a module in genetics. Learners in this activity were required to decide whether they can donate blood to a kid with cystic fibrosis.
Mockup: Iteration 1	Initial learning environment – A mockup of the module showing some of the activities, with instructions for learners. An initial navigation scheme should be present.	(As reference, see Figure 2b showing stage 6 – Mockup iteration 2).
Mockup: Iteration 2	Mature learning environment – A mockup of the module showing most of the activities with clear instructions for learners. A clear navigating scheme should be represented.	Figure 2b shows a sketch of one screen (from about 20 screens of the mockup which were developed by this group with a similar level of detail) of a module designed for teaching logical thinking for middle school math students. The buttons at the top and side of the screen are part of the whole learning environment's navigating scheme.

** The degree of maturity does not necessarily reflect the stage in the design process. (For instance, a mockup in iteration 2 can represent a degree of maturity less than 6).*

COMPARING BETWEEN COURSE ITERATIONS

To evaluate whether the sum of refinements made in the pedagogical model in each iteration in the previous study (Table 1) better supported students in designing their artefacts, we compare, in the current study, using the MODA rubric, between artefacts students created in each iteration of the course. Since students worked in groups, the sample for comparison is rather small; four groups in the first iteration, four additional groups in the second iteration and six groups in the third (a total of

14 groups). To provide more insight about the differences in the learning processes of students in each of the iterations, and to increase the trustworthiness of our claims (Stake, 1994), we chose three representative cases (one case per iteration) and describe the artefacts and design process of the group. The case-study groups were chosen by the degree of maturity the group reached, to represent the majority of groups in each iteration.

Figure 2. Examples of artefacts showing levels 4 and 6 of maturity in the MODA rubric

To evaluate whether the sum of refinements made in the pedagogical model in each iteration in the previous study (Table 1) better supported students in designing their artefacts, we compare, in the current study, using the MODA rubric, between artefacts students created in each iteration of the course. Since students worked in groups, the sample for comparison is rather small; four groups in the first iteration, four additional groups in the second iteration and six groups in the third (a total of 14 groups). To provide more insight about the differences in the learning processes of students in each of the iterations, and to increase the trustworthiness of our claims (Stake, 1994), we chose three representative cases (one case per iteration) and describe the artefacts and design process of the group. The case-study groups were chosen by the degree of maturity the group reached, to represent the majority of groups in each iteration.

OUTCOMES

Figure 3 shows a comparison between the 14 groups' final artefacts in each of the iterations as assessed using the MODA rubric. Although only 14 groups were examined in this comparison, a gradual progression can be seen in the artefacts in successive iterations of the course. In the following sections we illustrate this progression by describing the artefacts and design process of the three representative groups.

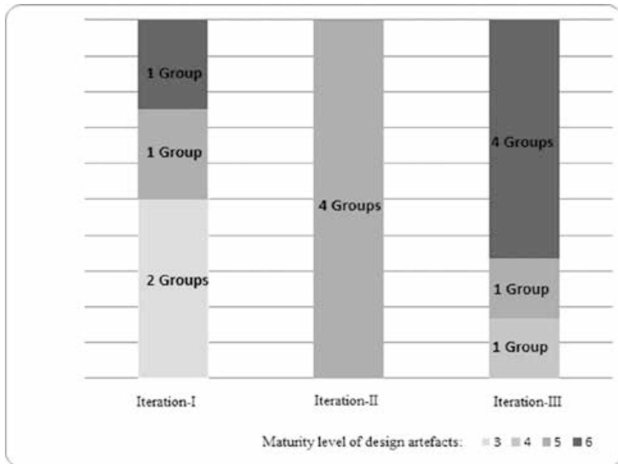

Figure 3. Comparison between students' final design artefacts in the three iterations, using the MODA rubric

The Design Process of B and P (iteration # I)

As can be seen in Figure 3, two of the four groups in the first iteration did not reach a degree of maturity higher than 3 in their final artefacts. This means that their artefacts included only an initial sequence of activities, there was no translation of design ideas into actual features, instructions for learners were missing, and activities were not represented within a general navigation scheme of the modules they designed.

An example of a group in this iteration, whose final artefact reached only this degree of maturity (# 3) is B and P, who designed a module for 10th grade physics learners. The topic they focused on was graphical representation of kinematics. According to their analysis document, their module sought to enable learners to explore the relationships between real world motions (created by learners using the mouse) and the automatically recorded graphical representation of these motions. The idea for this module came from B; his dissertation focused on the ways learners develop understanding of kinematics using such a tool. The motion-depicting tool had already been developed, and B wanted to use the course to help him develop activities around it. P, who came from a mathematics education background, was happy to collaborate.

Analysis of the design artefacts that B and P created at different stages of the design process showed that most of their design ideas stayed at the level of titles and were not translated into actual features (showing a difficulty to concretize their design ideas). Their final mockup included an illustration of the motion-depicting tool, with several buttons and a menu. The buttons and the options in the menu represented ideas for various explorations that learners could conduct in a certain sequence. However, these ideas stayed at an abstract level, and were not developed into actual activities.

Although this abstract level of thinking was very important at earlier stages of the design process (i.e. the *Content Analysis* and the *Brainstorm Activities* stages), at this stage B and P were required to translate these ideas into actual activities for the learner (concretize their design ideas), which seemed to be an obstacle for B. Based on several examples in our interaction with P and B regarding their design process, we believe that B clung to the abstract design ideas because he had a real difficulty to concretize them. Since he was the one who brought the idea, and was also in a more advanced stage in his dissertation, he was more authoritative in their group, and Ps efforts to concretize the ideas succeeded only to a small extent. The ability to reach a detailed and mature design artefact was not only related to each of the students' design skills, but also to social issues, such as the degree to which they were able to reach a productive dialogue within their group.

The Design Process of N and R (iteration # II)

In the following iterations (iterations II and III), there were no final artefacts such as the one described in the example above – all the final artefacts in these iterations represented higher degrees of maturity (#4 and above). As can be seen in Figure 3, all four groups in iteration II reached the fifth degree of maturity (Initial learning environment). The artefacts included some activities that were fully developed with instructions for learners and an initial navigation scheme, but these instructions were vague, and the navigation scheme was not clear.

An example case is N and R, who designed a module in bio-technology for middle school students. Their final artefact reached the fifth degree of maturity. Similar to the group described above, this group too, had design ideas with high pedagogical value and a difficulty to concretize them. Their learning path was slow until the last quarter of the course, only in the last three weeks of the course their artefacts changed from theoretical descriptions of what learners would do in their module, into artefacts that show how they would do so.

N and R's final mockup included a sequence with several sets of activities, each of which learners explore an ethical dilemma in bio-technology. We advised N and R to design in detail only one of these sets as a format for the others. The set of activities they designed commenced with introducing the dilemma (whether or not to conduct research in which human brain cells are transplanted into a mouse brain) via a simplified scientific article. Then, they designed a series of activities that would help learners make sense of the article. The next activity required learners to take a position, and explain it in a written essay. Finally, learners were required to share their written essays in a forum, and critique each other's work.

Although this seems like a well thought out sequence of activities, it was represented poorly in N and R's artefacts, and was actually elicited from discussions with them. In their final mockup a flow of activities was not laid out for learners, nor was it represented in the navigation scheme (a navigation scheme was present, but it was cumbersome), indicating a difficulty they had with concretizing their design ideas. Another problem with N and R's final mockup was that the instructions for learners were difficult to understand. For instance, the activity in which learners were required to read the scientific article was presented without any instructions. Only after several 'clicks' the words "read the text" appeared, without providing learners with a sense of purpose, or continuity of the task.

When we reviewed design documents that N and R produced earlier in the design process, we found that at the *Build Flow* stage they did not reach the level of detail required at this stage. The flow that they submitted consisted of theoretical and epistemological statements, such as "students should be provided with interesting science and with dilemmas…" or general ideas of the way learners would work in their module, such as "Learners will explore science and not learn it by heart". Our documentation revealed that actually, throughout the whole design process they did not plan possible sequences of activities. They started with designing several activities, which did not seem to have a straightforward connection between them. Feedback they received from us and from their peers brought up potential problems in learners' usage of these activities. The solutions that N and R came up with were in many cases ideas for actions that learners could take during, before or after the activity. In this manner, a flow of activities emerged in their module in the course of the design process, and without full awareness. In the final essay describing their module, they still described the activity-flow in a vague manner. Speaking in Goodyear's (2005) terms, it seemed that they had a difficulty to "see the wood" while focusing on the "trees" in the design work. However, the intensive feedback they received, brought them to overcome many of these difficulties, and eventually, to create an artefact that reached a degree of maturity required in stage 5, which shows a progression in their skill to concretize their design ideas.

The Design Process of I and O (Iteration # III)

As can be seen in Figure 3, four of the six groups, in iteration III, designed artefacts showing the highest degree of maturity (degree #6 in the MODA rubric). These artefacts represent full learning environments showing most of the activities, with clear instructions for learners and a clear and coherent navigation scheme.

One example of such an artefact was I and O's project. These students designed a module intended to help middle school math learners develop logical thinking by exploring example math and non-math problems. Our analysis of their artefacts at different stages of the design process, using the degree of detail in design artefacts rubric, showed that at each stage they reached the required level of detail. At the end of the course their mockup represented the highest degree (#6) of design artefact maturity.

The sequence of activities they designed started with comparing mathematical logic with everyday logic. In this first activity learners were required to choose between several stories, each presenting a dilemma in which they were asked to note the kind of evidence that would convince them of a certain claim. For instance, learners were presented with different kinds of evidence about the Loch Ness monster and had to say what additional evidence is needed to prove or disprove that it exists (Figure 3). Each group of learners was required to upload evidences to a forum which would serve as the basis for a whole class face to face discussion regarding the difference between mathematic and scientific proofs. The second activity consisted of exploration of historical claims, such as Fermat's theorem. Finally, in the third set of activities learners were required to prove mathematical claims. I and O explain in their design documentation that they deliberately chose claims in which both evidence and counter-evidence could easily be found. Each activity was represented in their mockup with detailed and clear explanations designed for middle school students, and with just-in-time supports. These supports were links to different kinds of databases (mathematical theorems, mathematical definitions, proofs) and tools (calculator, and data-grapher), which brought up information relevant to the task at hand. For instance, when learners work on the Loch Ness problem, they can link to the definitions database, which brings up an explanation of "proof by negation", and to an example of such a proof. Additionally, I and O designed for each activity notes for teachers with regards to how learners might be supported while working on the activity in class or at home. This example illustrates the high degree of maturity and concretization of ideas of final artefacts developed by students in this iteration, as well as their high level of pedagogical value.

In their reflective essays, both I and O noted the great impact of the course on their learning. Each of them noted several points that were specifically helpful in reaching their final artefact. These points match one to one with features we built into the pedagogical model via the iterative design process (Table 1).

DISCUSSION AND CONCLUDING REMARKS

The analysis of students' artefacts and their learning processes via the multiple case study approach provides more insight for understanding the difficulties they had with concretizing their design ideas. The three case studies described in the outcomes, show that moving from general design ideas to actual activities is a very difficult task for novice designers. B and P's design process is a good example illustrating how novices tend to stick to abstract ideas, and struggle in concretizing them. Although it was typically B who clung to abstract ideas, while P made efforts to build more detailed activities around them, their struggle, as a team, to translate their design ideas to concrete activities represents several other groups in this iteration who had similar difficulties, and eventually created final artefacts representing a relatively low level of maturity.

N and R's case shows that even when novices succeed to overcome the barrier of having to concretize their design ideas, and begin to spell out their initial design ideas into actions that learners might take while working with the module they are designing, other obstacles emerge. Concretization at a high level, in the context of educational technology design, requires not only to design the details of certain features, but also to be able to describe how these features fit together in a coherent learning environment, and to design different scenarios for learners to go through. This requires the designer to deal with very high level of detail of the activities, and at the same time envision a flow of activities or scenarios that would enable a potential learner to acquire knowledge using the designed module.

For N and R, the transitions from working on their module as a whole and working on the details of each activity were not easy. However, working their way throughout the course, and negotiating their ideas with peers and with the teachers, and the use of the design principles in the DPD enabled them to overcome this challenge, and eventually reach an artefact that we assessed as level 4 using the MODA rubric. As indicated from N's reflective essay, having to confront these difficulties, and specifically the difficulty of designing the details while envisioning the whole picture, was a process that she envisioned as crucial to her learning. We view this process as the development of concretization skills.

Finally, the case of I and O represents a design process supported by our most advanced pedagogical model in the third iteration of the course, in which most of the students gradually developed the skill to concretize their design ideas and eventually reached a design artefact representing mature learning environments (level 6 in the MODA rubric).

The comparison between artefacts designed by students in the three iterations, together with the descriptions of the three representative case-studies, show that students developed higher levels of the ability to concretize their ideas as the pedagogical model was refined. Or more specifically, the design decisions that we gradually implemented into the pedagogical model, as described in table 1 supported students to develop their concretization skills. These included: structuring the design process, using design principles in the DPD, integrating the pedagogical model in a design course, employing a cognitive apprenticeship model, adding collaborative aspects, moving the content analysis to an earlier stage in the process, adding another design cycle, adding face-to-face dialogic critique sessions between groups, and embedding the entire pedagogical model into the DPD. These design decisions, accumulated to become the pedagogical model, with the three general elements (ADDIE, Studio approach, and the use of the DPD). We would like to note that we view these elements, as described in more detail in Kali and Ronen-Fuhrmann (2011) as specific instantiations of three generic ideas, which we believe are an essential set of constructs for guiding educational technology design, and promoting the development of concretization skills: (a) structuring the design process (as we implemented via the ADDIE model), (b) building on accessible repositories of expert design knowledge (implemented in the current study by the use of the DPD), and (c) enabling dialogic learning (implemented via the studio approach).

We claim that students' development of the skill to concretize abstract design ideas represents a progression on a novice-expert continuum in the context of educational technology design. Papert and Resnick assert that "A technologically fluent person should be able to go from the germ of an intuitive idea to the implementation of a technological project" (in Resnick, Rusk, & Cooke, 1999, p. 266). This is exactly what the pedagogical model supported our novices to do.

Finally, this research shows that educational technology design is a multifaceted enterprise, which induces various challenges for different audiences. Much research has been dedicated to explore the novice-expert continuum in the context of instructional design. The current research indicates that in the context of educational studies, novices experience unique challenges when learning to design technology-enhanced learning environments. It seems that the skill to concretize design ideas, which instructional designers tend to posses even as novices, and which can bring them to suggest premature design solutions (Ertmer et al., 2009; Kerr, 1983; Rowland, 1992), is much less prevalent among graduate students in education.

Today, more and more teachers, from primary to tertiary levels, are expected to become designers of their own technology-enhanced curriculum modules (Goodyear & Retalis, 2010; Kali, Markuskaite, & Goodyear, 2011; Shamir-Inbal, Dayan, & Kali, 2009). The current research, by using a design-based research approach, provides insight into the unique challenges, namely—the ability to concretize design ideas—encountered by educators, as they learn to design such artefacts. By careful analysis of three iterations of design, implementation in real world settings and analysis, this research offers a generalized pedagogical model that can support those who are potential educators, curriculum-designers, learning-scientists, or policy makers in developing the skills required to progress on a novice-expert continuum in designing their own technology-enhanced learning environments. The MODA rubric developed in this study is offered as a tool to assess the degree of maturity of design artefacts in other contexts. Further studies using this rubric will enable to examine the role of concretization in the design process of a growing audience of people who take part in the endeavor of designing technology-enhanced learning.

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REFERENCES

Alexander, C. (1979). *The timeless way of building*. New York, NY: Oxford University Press.

Bannan-Ritland, B. (2008). Teacher design research: An emerging paradigm for teacher's professional development. In A. E. Kelly, R. A. Lesh, & J. Y. Baek, *Handbook of design research methods in education: Innovations in science, technology, enginnering and mathematics learning and teaching*. New York, NY: Routledge.

Cox, C., Harrison, S., & Hoadley, C. (2008). Applying the "studio model" to learning technology design. In C. DiGiano, S. Goldman, & M. Chorost (Eds.), *Educating learning technology designers: Guiding and inspiring creators of innovative educational tools* (pp. 145–164). New York, NY: Routledge.

Dick, W., Carey, L., & Carey, J. O. (2001). *The systematic design of instruction* (5th ed.). New York, NY: Addison-Wesley Educational Publishers.

Ertmer, P., Stepich, D., Flanagan, F., Kocaman-Karoglu, A., Reiner, C., Reyes, L., … Ushigusa, S. (2009). Impact of guidance on the problem-solving efforts of instructional design novices. *Performance Improvement Quarterly*, *21*, 117–132.

Goldschmidt, G. (2002). One-on-one: A pedagogic base for design instruction in the studio. In D. Durling & J. Shackleton (Eds.), *Proceedings of the design research society international conference* (pp. 430–437). Brunel University, Stoke-on-Trent, UK: Staffordshire University.

Goodyear, P. (2005). Educational design and networked learning: Patterns, pattern languages and design practice. *Australasian Journal of Educational Technology*, *21*(1), 82–101.

Goodyear, P., & Retalis, S. (2010). Learning, technology and design. In P. Goodyear & S. Retalis (Eds.), *Technology-enhanced learning: Design patterns and pattern languages* (pp. 1–27). Rotterdam, The Netherlands: Sense.

Green, L. N., & Bonollo, E. (2003), Studio-based teaching: History and advantages in the teaching of design, *World Transactions on Eng and Tech Edu, 2*(2), 269–272.

Gustafson, K., & Branch, R. (1997). Revisioning models of instructional development. *Educational Technology Research and Development*, *45*(3), 73–89.

Harel, I. (1991). *Children designers: Interdisciplinary constructions for learning and knowing mathematics in a computer-rich school*. Norwood, NJ: Ablex Publishing.

Herrington, J. A. (2006). Authentic e-learning in higher education: Design principles for authentic learning environments and tasks. In T. C. Reeves & S. Yamashita (Eds.), *Proceedings of world conference on E-Learning in corporate, government, healthcare, and higher education 2006* (pp. 3164–3173). Chesapeake, VA: AACE.

Hoadley, C. (2002). Creating context: Design-based research in creating and understanding CSCL. In G. Stahl (Ed.), *Computer support for collaborative learning 2002* (pp. 453–462). Mahwah, NJ: Lawrence Erlbaum Associates.

Hoadley, C., & Kim, D. (2003). Learning, design and technology: The creation of a design studio for educational innovation. In A. P. D. Reis & P. Isaías (Eds.), *Proceedings of the IADIS international conference e-Society 2003* (pp. 510–519). Lisbon, Portugal: IADIS Press.

Kafai, Y. (2006). Playing and making games for learning. *Games and Culture*, *1*(1), 36–40.

Kali, Y. (2006). Collaborative knowledge building using the design principles database. *International Journal of Computer Support for Collaborative Learning*, *1*(2), 187–201.

Kali, Y., & Ronen-Fuhrmann, T. (2011). Teaching to design educational technologies. *The International Journal of Learning Technology (IJLT)*, *6*(1), 4–23.

Kali, Y., Markauskaite, L., & Goodyear, P. (2011). Researching design practices and design cognition: Contexts, experiences and pedagogical knowledge-in-pieces. *Learning, Media, & Technology*, *36*(2), 129–149.

Kali, Y., McKenney, S., & Sagy, O. (2015). Teachers as designers of technology enhanced learning. *Instructional Science*, 1–7.

Kerr, S. (1983). Inside the black box: Making design decisions for instruction. *British Journal of Educational Technology*, *14*, 45–58.

Kolodner, J. L., Crismond, D., Fasse, B., Gray, J., Holbrook, J., & Puntembakar, S. (2003). Putting a student-centered learning by Design™ curriculum into practice: Lessons learned. *Journal of the Learning Sciences*, *12*, 495–548.
Linn, M. C., & Eylon, B. S. (2006). Science education: Integrating views of learning and instruction. In P. A. Alexander & P. H. Winne (Eds.), *Handbook of educational psychology* (2nd ed., pp. 511–544). Mahwah, NJ: Lawrence Erlbaum Associates.
Linn, M. C., Bell, P., & Davis, E. A. (2004). Specific design principles: Elaborating the scaffolded knowledge integration framework. In M. C. Linn, E. A. Davis, & P. Bell (Eds.), *Internet environments for science education* (pp. 315–340). Mahwah, NJ: Lawrence Erlbaum Associates.
McAndrew, P., & Goodyear, P. (2007). Representing practitioner experiences through learning design and patterns. In H. Beetham & R. Sharpe (Eds.), *Rethinking pedagogy for a digital age: Designing and Delivering E-learning* (pp. 92–102). Oxon: Routledge.
McKenney, S., & Voogt, J. (2012), Teacher design of technology for emergent literacy: An explorative feasibility study. *Australian Journal of Early Childhood*, *33*, 37–44.
Merrill, M. D. (2002). First principles of instruction. *Educational Technology Research and Development*, *50*(3), 43–59.
Mor, Y., & Mogilevsky, O. (2013a), *Learning design studio: Educational practice as design inquiry of learning 'Scaling up Learning for Sustained Impact'* (pp. 233–245). Berlin, Heidelberg: Springer.
Mor, Y., & Mogilevsky, O. (2013b), The learning design studio: Collaborative design inquiry as teachers' professional development. *Research in Learning Technology*, *21*.
Mor, Y., & Noss, R. (2008). Programming as mathematical narrative. *International Journal of Continuing Engineering Education and Life-Long Learning (IJCEELL)*, *18*(2), 214–233.
Mor, Y., & Winters, N. (2007). Design approaches in technology enhanced learning. *Interactive Learning Environments*, *15*, 61–75.
Papert, S. (1991). Situating constructionism. In I. Harel & S. Papert (Eds.), *Constructionism* (pp. 1–11). Norwood, NJ: Ablex.
Quintana, C., Reiser, B. J., Davis, E. A., Krajcik, J., Fretz, E., Duncan, R. G., ... Soloway, E. (2004). A scaffolding design framework for software to support science inquiry. *The Journal of the Learning Sciences*, *13*(3), 337–386.
Resnick, M., Rusk, N., & Cooke, S. (1999). Technological fluency and the representation of knowledge. In D. A. Schön, B. Sanyal, & W. J. Mitchell (Eds.), *High technology and low-income communities: Prospects for the positive use of advanced information technology* (pp. 263–286). Cambridge, MA: MIT Press.
Retalis, S., Georgiakakis, P., & Dimitriadis, Y. (2006). Eliciting design patterns for e-learning systems. *Computer Science Education*, *16*(2), 105–118.
Rowland, G. (1992). What do instructional designers actually do? An initial investigation of expert practice. *Performance Improvement Quarterly*, *5*, 65–86.
Schon, D. (1983). *The reflective practitioner: How professionals think in action*. New York, NY: Basic Books.
Shaffer, D. W. (2002), Design, collaboration, and computation: The design studio as a model for computer-supported collaboration in mathematics, In T. Koschmann, R. Hall & N. Miyake, (Eds.), *Computer support for collaborative learning 2* (pp. 197-222). Mahwah, NJ: Lawrence Erlbaum Associates.
Shamir-Inbal, T., Dayan, Y., & Kali, Y. (2009). Assimilating online technologies into school culture. *Interdisciplinary Journal of E-Learning and Learning Objects*, *5*, 307–334.
Stake, R. E. (1994). Case studies. In N. K. Densin & Y. S. Lincoln (Eds.), *Handbook of qualitative research* (pp. 236–247). Thousand Oaks, CA: SAGE Publications.
van den Akker, J. (1999). Principles and methods of development research. In J. V. D. Akker, N. Nieveen, R. M. Branch, K. L. Gustafson, & T. Plomp (Eds.), *Design methodology and developmental research in education and training* (pp. 1–14). Dordrecht, The Netherlands: Kluwer.
Voogt, J., Westbroek, H., Handelzalts, A., Walraven, A., McKenney, S., Pieters, J., & de Vries, B. (2011), Teacher learning in collaborative curriculum design, *Teaching and Teacher Education, 27*(8), 1235–1244.

Voogt, J., McKenney, S., Janssen, F., Berry, A., Kicken, W., & Coenders, F. (2012), *A framework for studying teacher learning by design.* Paper presentation at the Teachers as Designers of Technology Enhanced Learning pre-conference workshop in conjunction with the ISLS annual meeting. Sydney, Australia.

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4. A MULTI-DIMENSIONAL SPACE FOR LEARNING DESIGN REPRESENTATIONS AND TOOLS

INTRODUCTION

One of the core activities teachers perform as part of their professional practice is conceptual preparation of educational interventions of whatever type and at whatever level of granularity: single learning opportunities and activities, sequences, lessons, units, modules, courses or even whole programmes. A longstanding pillar in the constant quest for didactical efficacy, this preparation and planning is a field of study in its own right that is attracting renewed attention. This is thanks in large part to innovation brought about by the use of digital technologies throughout the educational sphere. The field is known by various names but perhaps the most commonly adopted, at least in Europe, is learning design (LD). This fast evolving field has become quite broad in scope and is now characterised by considerable diversity and complexity. For many, this rapid development is disorienting, making the field somewhat difficult to get to grips with. In an effort to address these challenges, and to contribute to a more systematic view of the field and its multitude of facets, this contribution illustrates and explains learning design in terms of one of its central tenants, namely design representations and tools. The chapter illustrates a set of different representation types and tools and proposes a multidimensional framework for positioning different approaches to learning design.

To this aim, it should be noted first of all that educators adopt a wide variety of methods, processes and tools for planning and preparing the activities they intend to enact for and with learners. However, there is a common thread running through this tapestry: the production of an artifact of some kind, whether it be just a few informal notes or a more elaborate and detailed form of representation. Elucidating, shaping, crystallizing and expressing intentions in this way is a process of design, in the sense that it concerns the formulation of the conceptual basis of an educational intervention in anticipation of its subsequent enactment. Representing one's thinking in a design artefact (of whatever form) can be regarded first of all as having a maieutic function, in that it calls on the teacher/designer to externalize, reflect on and assess her ideas. The design artifact then stands as a record of the author's (or authors') intentions, serving as a useful reference before, during and after enactment. Indeed, re-examing this record in the light of the experience gained

M. Maina et al. (Eds.), The Art & Science of Learning Design, 49–62.

from enactment can yield valuable insights: about initial assumptions, about the processes set in motion, about actors' performance, about outcomes and so on. As well as contributing to the practitioner/designer's professional efficacy and growth, these insights may be utilised for optimising the original design and for refining it for possible reuse, either by the author/s or by others. Indeed a key affordance of design artifacts is that they can be used to share information and knowledge about professional practice, especially among peers. This is a vital factor in a sector where practitioners have traditionally operated in relative isolation, even when working in adjacent classrooms day in day out.

So in the light of the above we can say that the essential role of the design artifact is to capture and communicate ideas, to the benefit of oneself and of others. Of course the advent of Information and Communication Technologies (ICT) has had a profound effect on all aspects of social communication, and the fields of endeavor addressed here are no exception, dependent as they are on reflection and communication processes. The use of ICT has opened up new didactical opportunities within education, while at the same time introducing a heightened degree of complexity both in learning processes and in their management. This in turn calls on practitioners to reconsider and perhaps change the approaches and tools they adopt for design, in a quest for more informed, methodologically sound and effective practice (Conole, 2012; Mor & Craft, 2012; Earp & Pozzi, 2006; Persico, 2006). The result has been increasing interest (and innovation) in the field of learning design, an endeavour that, for the most part, is identified with the employment of digital tools, resources and accompanying methods to support a systematic approach to design (Bottino et al., 2008).

This trend towards computer-supported learning design has helped to enrich, diversify and extend the possibilities for communicating design ideas both at an individual, maieutic level and as part of social processes. Depending on their priorities, practitioners may want to adopt digital tools for various learning design purposes: organising and retrieving design ideas for personal reference/reuse; conveying those ideas to (other) actors engaged in the enactment process (learners, facilitators, collaborating peers); passing them on to other practitioners and designers for discussion and possible adaption/reworking, towards reuse in other settings and contexts; sharing them with researchers as part of pilots devoted to educational innovation of some kind.

Design artefacts can be expressed in languages and forms of different kinds, ranging from simple outline sheets to machine-readable representations that automatically configure a digital learning environment in which the design is deployed and activities enacted. Currently, there exists a wide variety of representational forms conceived for different purposes, users and contexts, and this may make it difficult for non-specialist practitioners, especially novices, to get to grips with the learning design field. This paper is an attempt to provide a systematic view of existing design representations forms, even though the borders between the various categories proposed can be rather blurred.

There are a number of dimensions along which it is possible to classify existing representations, tools and approaches in the field of design for learning. Gibbons et al. (2008) identify seven continuums along which it is possible to position the various design languages: complexity – simplicity; precision – non precision; formality – informality; personalization – sharedness; implicitness – explicitness; standardization – non standardization; computability – non computability. Agostinho (2008) and Conole (2010) also provide an overview of the range of representations used to describe learning designs and other outcomes of the same process, showing how they can be used to foreground different aspects of design development.

The present contribution builds upon previous work in this area to propose a multi-dimensional framework that is intended as a conceptual tool for classifying different design approaches and representation forms, thus also shedding light on areas where further research work is needed.[1]

DESIGN REPRESENTATION FORMATS: AN INITIAL OVERVIEW

Design representations can vary in format. Broadly speaking, formats fall into two main categories: textual representations (languages) and visual representations. According to Conole (2012), textual representations are expressed in either artificial/formal or natural language (narratives), while visual representations basically rely on a graphical format. In the following these types are described in general terms; concrete illustrative examples are introduced and examined in the Discussion section.

In LD, artificial textual languages are generally used to encode and convey a design in a highly formalized way, usually so that it can be processed by a computer. This makes it possible to deliver relevant components of a learning activity directly to learners or provide for automatic configuration of a suitable computer-based learning environment in which the activity can take place. Describing a design through such formal languages is usually a fairly technical matter. Consequently, it may call for a professional with the necessary technical competences to act as a 'bridge' between teacher-designer and computer. More commonly, a high-level interface is adopted to 'mask' the technicalities, thus allowing the teacher to focus mainly on design considerations.

Textual representations based on natural language, instead, are largely 'narratives', i.e. descriptions of designs, plans or experiences based on words. As such they typically have a low degree of formalism. However, they are often based on a pre-defined skeletal structure or template proposing an organized schema of descriptors/ fields for expressing the various aspects of the design. This scaffolds the author through the design process, suggesting what choices and decisions are to be made, and what information is required at what level of detail.

Some narrative forms place the accent on essential context-independent information at the expense of more detailed context-related data, which may even be excluded altogether. This bias towards abstraction is partly an endeavour to foster (efficient) communication of a design's essence, but more importantly it is an (informal) attempt to facilitate reuse through generalisation. It must be recognised, however, that these do not in themselves constitute a guarantee of enhanced reuse capability.

Other kinds of narratives, as explained further hereunder, are intended to include more detailed information, which may be related to the pedagogical rationale behind the intervention and/or the details of the 'enactment' phase. In a sense, the latter 'fleshes out' the design skeleton with tangible description of the way the learning activity has been or can be used, the context that the activity is intended for, the target population to be addressed, the prerequisites, etc.

Let's now turn to visual representations. These generally take the form of diagrams or graphs, which convey an overall view of the design or specific aspects thereof, such as the structure of the intervention, the learning objectives, the contents to be addressed, the roles of the people involved, etc. Diagrams or graphs are a means for schematically representing the main entities within a design and the relationships between them; common examples include flow charts, content maps and swim lanes.

Charts, on the other hand, are visual representations of quantitative data from the intervention. Typical examples here are bar or pie charts representing features of the learning process, based on suitable indicators. These charts can foster reflection by focusing the author's attention on specific aspects of the design shown in the representation (San Diego et al., 2008).

As we shall see in the following, textual and visual representations may in principle be used autonomously, but more commonly than not they are used in conjunction with each another. This is useful, perhaps even necessary, for fulfilling the dual purposes of a design representation, namely capturing salient design concepts and conveying that information effectively to others (Falconer et al., 2007).

AUTHOR AND END-USER

A learning design representation may be authored by an individual educator or by a team of teachers and/or designers. Unless 'average' teachers have recourse to a high-level tool, dealing with artificial languages is unlikely to be cost-effective for them; they would probably feel more at ease with narratives. As already mentioned, the (present) inavailability of such tools beyond prototype status means that artificial language use can require the intervention of an intermediary to transform the teacher's design into some sort of runnable code.

Visual representations are typically adopted for the intuitive, user friendly qualities they can bring to design and, provided the formalisms within them are not too obtuse, they can generally be used by any author, be they a teacher and/or a designer. Indeed this is usually the very reason why recourse is made to visual representation in the first place.

As already mentioned, design representations may be intended primarily for communicating with other authors and/or educators, but they may also be intended as a way of conveying design information directly to learners themselves.

Lastly come those representations whose main or sole mission it is to scaffold the author and foster their reflection through the design process. These representations can be seen as half-baked artifacts whose principal beneficiaries are the individual authors themselves. However, in a truly participatory culture of learning design, they could also function as knowledge-sharing synapses that facilitate the exchange of emergent ideas and practice. Once consolidated, these could then serve to enrich the final learning design artefact. By the same token it should be recognised that authors can be quite reluctant to share early drafts of their work, as substantiated by Pozzi and colleagues (Pozzi, Persico, & Sarti, 2014).

‘CONTINUUMS’ FOR LEARNING DESIGN REPRESENTATIONS

In an attempt to map existing representation forms, it is possible to identify two dimensions or ‘continuums’ along which any representation can in principle be placed. One is the degree of *formalism;* some representations are characterized by high levels of formalism, while others are fairly informal. The other is the degree of *contextualization;* representations can provide very concrete or very abstract information.

The degrees of formalism and contextualization are strictly interrelated and often the level of one dimension influences the level of the other. Furthermore, these two dimensions impact on the malleability of a learning design *in toto,* i.e. the degree to which a design can be reshaped, remixed and reappropriated in new situations. In the following the two dimensions are briefly described.

Degree of Formalism

A representation’s level of formalism regards the degree to which its use entails observation of fixed syntactic and semantic ‘rules’. Some representations have very strict rules and are therefore highly formalized. Others impose no such rules, granting the author freedom of expression but at the same time leaving ample space for ambiguities.

Typically the degree of formalism is high for artificial languages such as in the case of the IMS-LD specification (Koper, 2006) but low for natural languages.

Graphical representations typically have a moderate degree of formalism, although there is a degree of variance. For example, some schematic diagrams feature elements that are defined in absolute terms and are therefore highly formal. Others, such as CompendiumLD, adopt symbols whose semantics are not formally defined, and thus leave space for a degree of subjective interpretation. However, we should not forget that, as already mentioned, visual representations rarely provide exhaustive design information and so more often than not they are accompanied by narrative. This, of course, limits the degree of formalism of the resulting representation.

The degree of formalization is also proportionally related to the ease of automation; generally speaking the higher the former, the higher the latter. It is also associated to some extent to the reusability of the design, which is generally higher for more formal languages. However, it should be noted that reusability does not depend on formalization alone, far from it.

Degree of Contextualization

Another interesting dimension is the degree of contextualization. Butturi and Stubbs (2008) distinguish between 'sketch-oriented representations' that provide an outline, and representations that enable details to be specified. In principle, the idea is that the more abstract the design, the greater the scope for reusability. At the same time, however, when details are missing, automation becomes impossible.

As already mentioned, natural language representations may provide considerable detail (encompassing information about the enactment phase, for example) or may be focused at a more general level, providing only an abstract picture of the proposed activity (Conole et al., 2011).

Graphical representations tend to give rather abstract information, but it is not unusual to see graphs of different kinds, like concept maps, used in conjunction with texts. The graph provides an overall idea of the design but it may also embed detailed narrative information that can be accessed interactively, for example by clicking on a single node/symbol to display related text.

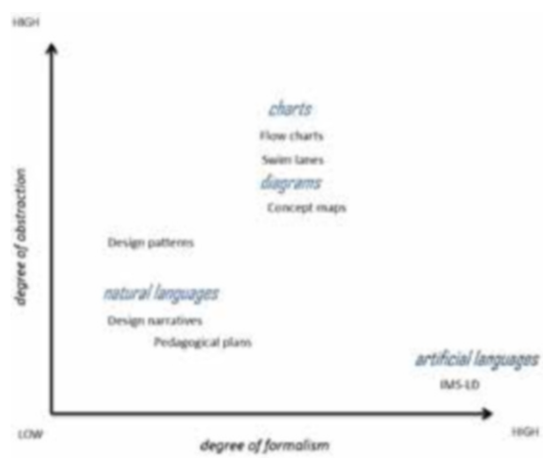

Figure 1. LD representation formats mapped by 'contextualization' and 'formalism' dimensions

Since the two dimensions (formalism and contextualization) are 'continuums' of sorts, it is possible to see them as axes, along which one may locate the various representations commonly adopted in the field. For the sake of simplicity and immediacy, we have chosen to group these into general representation types, as shown in Figure 1. Of course this is an over-simplification, but the idea here is merely to show that any representation can in principle be mapped along the two axes.

PURPOSES OF REPRESENTATIONS

Generally speaking, 'design languages can be used to generate designs and as a mechanism for interpreting and discussing them' (Conole, 2012). In a similar vein to the proposal made by Botturi and Stubbs (2008), who distinguish between 'finalist communicative languages' and 'representative languages', we contend that representations can be viewed in terms of *purpose*. In some cases the representation is oriented more towards the actual design process, while in others communicating design ideas through the sharing of design representations is the main aim. A third type of purpose is that of supporting automatic configuration of ready-to-use learning environments.

Generally speaking, we can distinguish between 'representations for personal use' (i.e. representations keyed to the designer's authoring and reflection processes), 'representations for social use' (when the designer's main concern is to communicate ideas to peers) and 'representations for institutional use' (when the designer wants to deliver the design to learners). Even if the borders between these categories are rather blurred, and representation forms are often blended to meet multiple purposes, some representations seem better suited – and more effective – for supporting one or the other.

Figure 2. LD representation types and purposes

Figure 2 sets the main representation types against the main purposes. While representations based on natural languages generally serve the purposes of generating, reflecting on and/or communicating the design, artificial languages for design representation mostly have the purpose of delivering an activity to students. Diagrams can be used to generate, reflect on and communicate the design to others, while charts are often used as *a posteriori* tools to reflect on design choices.

Again, it is worth stressing here that different representation types are commonly combined and thus serve multiple purposes.

DISCUSSION: MAPPING REPRESENTATIONS WITHIN THE FRAMEWORK

Summarising the considerations made thus far, the framework adopts four general representation types (natural and artificial languages, diagrams and charts) and positions these bi-dimensionally in terms of varying degrees of formalism and of contextualization (Figure 1). Additionally, the framework sets the four types between poles of purpose and sections them according to four general functions (generate, communicate, reflect, deliver) (Figure 2). The relations between these dimensions may be viewed from different directions and at different levels, and this aspect is briefly examined in the conclusions.

In the following, we discuss the proposed framework using examples of existing representations (or tools implementing specific representations) and position these within the proposed dimensions. The list of representations chosen for this exercise is not exhaustive; the selection has been made mainly on the basis of the representations discussed within the LDG Theme Team, which inspired this work.

As a first example let's take so-called Design Narratives (Mor, 2011), which are accounts of critical events in a design experiment from a personal, phenomenological perspective. Design Narratives are usually focused on design in the sense of problem solving, describing a problem in the chosen domain, the actions taken to resolve it and their unfolding effects. They provide an account of the history and evolution of a design over time, including the research context, designated tools and activities, and the results from users' interactions with these. The level of contextualization is fairly high in this representation but, by the same token, the degree of formalism is low. The purpose of this text-based representation can be both personal and social, as it can be used both for reflection and as a communication artifact. In the latter case, though, one should consider that the level of reusability of narrative-based designs *per se* is not particularly high. However, they can be used as inspirational objects for the design of new artifacts, as in the case of the SNaP! framework (Mor, 2013), where narratives were used as raw material for constructing 'patterns'.

Among the textual representation forms that lend themselves best to communicating overall design and sharing it with others for reuse, one that figures prominently is the so-called 'Pedagogical Pattern' (Anthony, 1996; Bergin, 2002; Eckstein et al., 2002; Laurillard, 2012). While patterns are also written descriptions and are based on a precise descriptor schema (Problem, Forces, Solution, etc.), the aim here is to leave aside any contextual information and consider the design as a general – and generalizable – approach to a commonly occurring problem, thus facilitating application/reuse in multiple contexts. Pattern forms related to Pedagogical Patterns include e-learning design patterns (Kohls & Wedekind, 2010) and Collaborative Learning Flow Patterns. The former were first proposed in the E-LEN European project (AA.VV., 2005) and later developed further by McAndrew, Goodyear and Dalziel (2006) amongst others. The latter capture and propose techniques that practitioners typically adopt for structuring activities in collaborative learning situations (Hernández-Leo et al., 2005).

So, comparing the positon of Design Narratives and Pedagogical Patterns in the proposed framework, we see that even if they are both text-based representations, they embody different levels of contextualization and have different purposes (reflection for the former and sharing and reuse for the latter).

A textual format combined with a predefined descriptor schema can also be used to scaffold the design authoring process. Examples are provided by systems that present the author with a set of empty fields that are to be filled with relevant information such as intended learning objectives, features of the target population, tools required, etc. Hints, prompts or suggestions may be on hand for completing the data. In some cases the system may also present a closed set of values from which to choose, e.g. target population = primary / secondary / higher education. The user is thus guided through the design process, with the help of prompts intended to crystallize design decisions and stimulate reflection. In this sense the descriptor schema (through its structure and attendant prompts/values) acts as a maieutic tool (Olimpo et al., 2010) that helps the author fashion initial (and perhaps as yet ill-defined) ideas into a detailed, systematic description of the learning intervention (Britain, 2007): how it is structured, what the objectives are, what the learning outcomes may be, what tasks learners will carry out in pursing the objectives, what materials are to be used, what time schedule is foreseen, etc. Examples of such descriptor schemas can be found in the Pedagogical Plan Manager[2] (PPM), in Dialog Plus[3] or in Learning Designs.[4] Although there is some variation in the descriptor schemas that these tools propose, they all support the design process through the definition of more-or-less common elements: learning context, intended outcomes, rationale, tasks for learners to perform, required resources, chosen educational approach, assessment methods, etc. These kinds of representation clearly have a high level of contextualization and – as they are based on natural language – the degree of formalism is fairly low. Such representations are fairly easy for the ‘average teacher’ to handle as they do not require specialised technical knowledge. Indeed, they are largely aimed at the sharing of design ideas among a cohort of teachers, even though they may also be shared with students as well to scaffold the learning process.

Learning design tools provide tangible support for the generation and communication of design ideas and, in some cases, represent a conduit for enactment with learners. Many of those currently available generate designs centred on visual representation, where graphical design forms, swim-lanes and flow-charts may be used to visualize overall structure (or aspects thereof). The main advantage here is that the design can easily be shared with other authors, or communicated directly to students. Notable examples of flow chart use are LAMS[5] (Dalziel, 2003) and MOT+ (Paquette et al., 2008). Swim-lane learning designs represent salient elements such as tasks, actors involved, learning objectives, and contents. Examples of tools handling swim-lane representations are: CompendiumLD,[6] a very flexible tool that manages swim-lanes of different kinds; CADMOS,[7] which allows both swim-lanes and flow-charts so as to afford different perspectives on the same design; and LDSV (Agostinho, 2011). Hierarchies or tree structures can also be used to display and communicate the overall structure of an envisaged intervention. Such representations are implemented in the Pedagogical Plan Manager (PPM). While in these cases the primary purpose of diagrams and graphs is to communicate the design to others, some also provide scaffolding for the authoring process and for reflection.

In any case, these diagrams have a fairly low degree of contextualization, given that information is provided in a synthetic way, and so they are often accompanied by additional textual data. Indeed, all the tools listed above make use – in one way or another – of textual information to integrate the overall view provided by graphs. In the case of tools based on 'double representations' (visual + textual), positioning within the proposed framework is more complex and hence somewhat problematic. This aspect is examined in the conclusions below.

Representations that scaffold decision-making also include content maps, which may not only serve to provide an overview of contents, but also to reason and make choices about the content domain that a design addresses. Similarly, teachers also use representation tools like concept maps or Petri Nets during the design phase to elicit key elements in the design and the relationships between them. These representations may also be used later on for sharing purposes, given that they are based on symbols and signs that can be easily interpreted by others (intermediate/high level of formalism).

Furthermore, diagrams are sometimes used as representation tools for describing the theoretical approach or framework underpinning a design. One prime example is the well-known Activity Theory diagram (Engeström, 1999), which is often used as a basis for representing learning activities inspired by that approach. Other representation forms adopted to illustrate the implementation of a specific approach include the 4Ts model[8] for online collaboration and the 4SPPIces model (Sanagustin et al., 2012) for blended learning. Schematic diagrams are also used to to map out a course or the overall structure of an intervention; two tools that adopt representations of this kind are Collage and Web Collage (now Web Instance Collage), which represent pedagogical patterns such as Jigsaw and Pyramid[9] in visual form.

Another kind of representation capable of scaffolding reflection on data is the chart. Charts are generally used to analyse and reflect on aspects of a design *a posteriori*, i.e. after the design has been completed or even deployed. Pie charts may be employed, for example, as a means to reveal the balance between different kinds of learning strategies adopted within a given intervention. The final aim may be to fine tune the design or evaluate the learning experience. Examples of these charts are implemented and used in the Learning Designer.[10] Here again, formalism and contextualization are at an intermediate level.

A last category of representation, mainly aimed at enactment, is the artificial language: machine-readable artificial languages like IMS-LD, E2ML and LDL (Martel et al., 2006) have the explicit purpose of supporting the authoring of designs as computerized artifacts for delivery to learners. In these representations formalism is of course at the highest levels, while contextualization is usually high, because details needed for implementation are included.

CONCLUSIONS

This contribution proposes and discusses a multi-dimensional framework for positioning different learning design representations. The main aim of the framework is to help practitioners gain a better understanding of the field and how different representation forms might suit their purposes. The framework may also serve researchers and tool developers by highlighting areas for further investigation and potential for tool development. An overarching ambition is to provide a sound systematic basis for the process of designing for learning, and for developing effective design tools that not only support design authoring, but also scaffolf the critical decision-making typical of the design process.

In order to illustrate the framework from both the conceptual and functional viewpoints, an attempt has been made to position common representation types within the proposed dimensions. The results suggest that this approach constitutes a basis warranting further development and refinement.

One aspect for further investigation is the case of representations that make joint use of two (or more) representation types (typically textual + visual). Single, distinct representation types are fairly easy to position within the framework, while instances of variegation are more problematic. So one emergent research question is how, and how best, textual + visual forms can be adopted to meet the range of purposes falling within the personal vs. social polarity, in accordance with the formalism and contextualization sliding scales. This touches on quite complex questions of semiotics that are beyond the scope of this paper but offer interesting paths for future investigation. Another area for further investigation is the multiform relationship between the different dimensions adopted in the framework and how best these might be captured in single graphic form that embodies the necessary simplicity with sacrificing (intrinsically complex) meaning.

Clearly, the need emerges for further work in the mapping/classification of representations and perhaps some degree of integration among the tools that reify those representations, possibly within a single environment. This need, together with that for a more structured view of design tools, is the starting point of a project called METIS,[11] funded by the EU under the Lifelong Learning Programme. METIS aims to develop a learning design environment based on the integration of existing tools and methods so as to ultimately provide more effective support for practitioners in the field of learning design.

NOTES

[1] We acknowledge that many of the considerations made herein derive from the work carried out by the 'Learning Design Grid' (LDG) STELLAR Theme Team, which was active from Autumn 2011 to Spring 2012 and produced a Practitioner's Guide to Learning Design.
[2] http://ppm.itd.cnr.it
[3] http://www.dialogplus.soton.ac.uk/
[4] http://www.learningdesigns.uow.edu.au/
[5] http://www.lamsinternational.com/
[6] http://compendiumld.open.ac.uk/
[7] http://cosy.ds.unipi.gr/cadmos/
[8] http://www.ld-grid.org/resources/representations-and-languages/4-ts-model
[9] http://www.gsic.uva.es/collage/
[10] https://sites.google.com/a/lkl.ac.uk/ldse/
[11] http://metis-project.org/index.php

REFERENCES/BIBLIOGRAPHY

Agostinho, S. (2008). Learning design representations to document, model, and share teaching practice. In L. Lockyer, S. Bennett, S. Agostinho, & B. Harper (Eds.), *Handbook of research on learning design and learning objects: Issues, applications, and technologies* (pp. 1–19). Hershey, PA: Information Science Reference.

Agostinho, S. (2011). The use of a visual learning design representation to support the design process of teaching in higher education. *Australasian Journal of Educational Technology*, *27*(6), 961–978.

Anthony, D. L. (1996). *Patterns for classroom education*. Retrieved November, 2012 from http://ianchaiwriting.50megs.com/classroom-ed.html

Bergin, J. (2002). *Fourteen pedagogical patterns. Pedagogical patterns project*. Retrieved November, 2012 from http://www.pedagogicalpatterns.org/

Bottino, R. M., Earp, J., Olimpo, G., Ott, M., Pozzi, F., & Tavella, M. (2008). Supporting the design of pilot learning activities with the pedagogical plan manager. In M. Kendall & B. Samways (Eds.), *Proc. IFIP, Learning to live in the knowledge society* (Vol. 281, pp. 37–44). New York, NY: Springer Sci.Business Media.

Botturi, L., & Stubbs, T. (2008). *Handbook of visual languages for instructional design: Theories and practices*. Hershey, NY: Information Science Reference.

Britain, S. (2007). Learning design systems: Current and future developments. In H. Beetham, & R. Sharpe (Eds.), *Rethinking pedagogy for a digital age* (pp. 103–115). New York, NY: Routledge.

Conole, G. (2010). An overview of design representations. In L. Dirckinck-Holmfeld, V. Hodgson, C. Jones, M. de Laat, D. McConnell, & T. Ryberg (Eds.), Proceedings of the 7th International Conference on Networked Learning 2010. June 2013. Retrieved from http://celstec.org/system/files/file/conference_proceedings/NLC2010_Proceedings/abstracts/PDFs/Conole_2.pdf

Conole, G. (2012). *Designing for learning in an open world*. New York, NY: Springer.

Conole, G., McAndrew, P., & Dimitriadis, Y. (2011). The role of CSCL pedagogical pattern as mediating artifacts for repurposing open educational resources. In F. Pozzi & D. Persico (Eds.), *Techniques for fostering collaboration in online learning communities: Theoretical and practical perspectives*. Hershey, New York, NY: Information Science Reference.

Dalziel, J. R. (2003). *Implementing learning design: The learning activity management system (LAMS)*. Paper presented at the ASCILITE 2003 Conference, Adelaide, Australia.

Earp, J., & Pozzi, F. (2006). *Fostering reflection in ICT-based pedagogical planning*. In R. Philip, A. Voerman, & J. Dalziel (Eds.), *Proc. First Int. LAMS Conference 2006: Designing the future of learning* (pp. 35–44). Sydney, Australia: LAMS Foundation.

Eckstein, J., Bergin, J., & Sharp, H. (2002). *Patterns for active learning*. Paper presented at the 9th Conference on Pattern Language of Programs, Monticello, Illinois.

E-LEN project team (2004). *Design expertise for e-learning centres: Design patterns and how to produce them*. E-LEN project under the EU Socrates Programme.

Engeström, Y., Punamäki-Gitai, R. L., & Miettinen, R. (1999). *Perspectives on activity theory*. Cambridge, UK: Cambridge University Press.

Falconer, I., Beetham, H., Oliver, R., Lockyer, L., & Littlejohn, A. (2007). *Mod4L final report: Representing learning designs*. Glasgow, UK: Glasgow Caledonian University.

Gibbons, A. S., Botturi, L., Boot, E., & Nelson, J. (2008). Design languages. In M. Discoll, M. D. Merill, J. V. Merrienboer, & J. M. Spector (Eds.), *Handbook of research for educational communications and technologies.* Mahway, NJ: Lawrence Erbaum Associates.

Hernández-Leo, D., Asensio-Pérez, J. I., Dimitriadis, Y., Bote-Lorenzo, M. L., Jorrín-Abellán, I. M., & Villasclaras Fernández, E. D. (2005). Reusing IMS-LD formalized best practices in collaborative learning structuring. *Advanced Technology for Learning*, 2(4). doi: 10.2316/Journal.208.2005.4.208-0865

Kohls, C., & Wedekind, J. (2010). *Investigations of e-learning patterns: Context factors, problems and solutions*. Hershey, PA: IGI Global.

Koper, R. (2006). Current research in learning design. *Educational Technology & Society*, *9*(1), 13–22.

Laurillard, D. (2012). *Teaching as a design science: Building pedagogical patterns for learning and technology*. New York, NY: Taylor & Francis/Routledge.

Martel, C., Vignollet, L., Ferraris, C., & Durand, G. (2006). *LDL: A language to model collaborative learning activities*. Paper presented at EDMEDIA2006 – World Conference on Educational Multimedia, Orlando.

Mor, Y. (2011). *Design narratives: An intuitive scientific form for capturing design knowledge in education*. *6th Chais conference – Learning in the technological era* (pp. 57–63). Israel: Open University.

Mor, Y. (2013). SNaP! Re-using, sharing and communicating designs and design knowledge using scenarios, narratives and patterns. In R. Luckin, P. Goodyear, B. Grabowski, S. Puntambekar, N. Winters, & J. Underwood (Eds.), *Handbook of design in educational technology* (pp. 189–200). London, UK: Routledge.

Mor, Y., & Craft, B. (2012). *Learning design: Reflections upon the current landscape*. Research in Learning Technology – Supplement ALT-C 2012 Conference Proceedings. Retrieved June, 2013 from http://www.researchinlearningtechnology.net/index.php/rlt/article/view/19196

McAndrew, P., Goodyear, P., & Dalziel, J. (2006). Patterns, designs and activities: Unifying descriptions of learning structures. *International Journal of Learning Technology, 2*(2/3)*,* 216–242*.* doi:10.1504/IJLT.2006.010632

Neumanna, T., Darren P., Sanagustin, M. P., Emin, V., & Hernandez-Leo, D., (2012). Considering the space in the design of learning activities: The ISIS and 4SPPIces models applied to science inquiries. In *Proc. of the 2012 IEEE 12th International Conference on Advanced Learning Technologies (ICALT)* (pp. 159–163).

Olimpo, G., Bottino, R. M., Earp, J., Ott, M., Pozzi, F., & Tavella, M. (2010). Pedagogical plans as communication oriented objects. *Computers & Education*, *55*, 476–488.

Paquette, G., Léonard, M., & Lundgren-Cayrol, K. (2008). The MOT+ visual language for knowledge-based instructional design. In L. Botturi & S. T. Stubbs (Eds.), *Handbook of Visual languages for instructional design: Theories and practices* (pp. 133–154). Hershey, NewYork, NY: Information Science Reference.

Persico, D. (2006). Media selection from the teacher's point of view. In A. Cartelli (Ed.), *Teaching in the knowledge society*: *New skills and instruments for teachers* (pp. 286–301). Hershey, PA: Information Science Publishing.

Pozzi, F., Persico, D., & Sarti, L. (2014). *METIS D5.2: Report on first formative evaluation round*. Retrieved from http://metis-project.org/resources/deliverables/METIS_D5-2.pdf

San Diego, J. P., Laurillard, D., Boyle, T., Bradley, C., & Ljubojevicb, D. (2008). Towards a user-oriented analytical approach to learning design. *Research in Learning Technology, ALT-J*, *16*(1), 15–29.

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SECTION 2

METHODS

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5. TOWARD RELEVANT AND USABLE TEL RESEARCH

INTRODUCTION

Internationally, society is increasingly demanding that the relevance and practical applicability of research be made transparent. Despite intentions to the contrary, insights on pedagogically appropriate uses of educational technology for representative teachers in everyday school settings are severely limited. Moreover, there is a problematic gap between what could be effective TEL in theory, and what can be effective TEL in practice. This chapter calls for designers/researchers of TEL to devote attention to not only fine-grained issues of pupil learning and instruction, but also to broader factors that determine if and how innovations are understood, adopted and used by teachers and schools. Methodological considerations are given for designing and studying interventions that are prone to implementation by being: value-added, clear, harmonious and tolerant.

Society in general and research foundations around the globe such as the European Research Council and the (American) National Science Foundation are increasingly calling for the relevance and practical applicability of research to be made transparent. Prompted largely by stronger climates of accountability, there is increased societal participation in the mechanisms that guide research, including the many panels set up to assess the social relevance of governmentally-funded research across fields. Researchers are being asked to ensure that scientific knowledge is 'socially robust', and that its production is not only seen but also experienced by society (Gibbons, 1999). Despite intentions to the contrary, research on technology enhanced learning (TEL) that truly serves current educational practice is more rare than it is common (cf. Reeves, Herrington, & Oliver, 2005). Insights on pedagogically appropriate uses of educational technology for representative teachers (i.e. typical teachers whose habits and concerns are representative of the majority) in everyday school settings are severely limited. In part, this is because (design) research is conducted at the bleeding edge of what is technologically possible – exploring innovative uses of new and emerging technologies. There is no disputing that such work is greatly needed to seek out new ways to potentially enhance the quality of teaching and learning. However, in the excitement of exploring what is possible, tomorrow, there is insufficient research and development work focusing on what is practical,

M. Maina et al. (Eds.), The Art & Science of Learning Design, 65–74.

today. This leaves a problematic gap between what could be effective TEL in theory, and what can be effective TEL in practice. With the aim of generating 'usable knowledge' (cf. Lagemann, 2002) and creating innovations that truly serve learning in practice, this chapter calls for designers/researchers of TEL to devote attention to not only fine-grained issues of student learning and instruction, but also to broader factors that determine if and how innovations are understood, adopted and used by teachers and schools. Allowing these issues to steer the design of TEL innovations is necessary to yield innovations that can feasibly be implemented outside of (often highly enabling) research and development trajectories.

CURRENT SHORTCOMINGS OF TEL (DESIGN) RESEARCH

There is no shortage of literature critically assessing the educational impact of the TEL (or lack thereof), and why innovations tend to fail. Common problems in the implementation and/or maintenance of TEL innovations demonstrate that, with regularity, insufficient attention is given to anticipating and designing for educational realities. For example, within the classroom, problems commonly stem from poor alignment between innovations and classroom curricula (Cuban, 2001), e.g. such as when technology is used to support deep inquiry that is more narrow than the topics addressed in the students' textbooks and attainment targets. In some cases, TEL innovation design downplays, or flat-out or ignores key elements of the system which powerfully influence implementation (McKenney, Nieveen, & van den Akker, 2006), such as assessments, technology policies and infrastructure. Many innovative initiatives over-estimate the interest and expertise of teachers (Knezek & Christensen, 2008); this is not just related to technology and or (pedagogical) content knowledge, but also related to the interest and expertise that is required to orchestrate technology use to give students access to/guidance on the technology. Often, insufficient attention is given to inculcating practitioner understanding and ownership of the innovation and its underpinning ideas (cf. Tebbutt, 2000); the results can be that teachers experience TEL innovation as an extra, irrelevant burden and not as a way to meet existing goals in value-added ways. Finally, many innovations fail because they focus on delivery and not on pedagogy (Reeves, 2011); heavy emphasis on specific media (iPads, serious games, interactive white boards, etc.) frequently overshadows the teaching and learning they are intended to support.

Looking broader than classroom innovations alone, researchers at the Open University of the Netherlands identified six 'sure-fire causes of failure' for ICT innovations (OUNL, 2005). These are:

- Lack of balance between investments and output: High investment with low output;
- Information politics: Institutional power is abused and information is not transmitted to all stakeholders in timely and/or complete fashion;

- Lack of responsibility: uncertainty about the responsibility of people inside and outside the project;
- Culture gap: The gap between technology specialists and the rest of the organization, as well as between those the planners and enactors of education;
- Over-commitment: Not knowing when to cut losses and stop a project; and
- All-in-one solutions: Trying to do everything at once instead of using multiple projects, steps, and phases.

The shortcomings of TEL (design) research are not only measured in terms of innovation failure. They can also be measured in terms of innovation focus. Often, technology-based innovations are conceived of by good-willed technology enthusiasts, seeking to design, develop, and try out new possibilities. However, in so doing, opportunities are frequently missed to address more urgent issues in schools. This issue plagues much educational research and is especially applicable to that involving technology. The words of Schön (1995, p. 28) are applicable here:

> In the swampy lowlands, problems are messy and confusing and incapable of technical solution. The irony of this situation is that the problems of the high ground tend to be relatively unimportant to individuals or to the society at large, however great their technical interest may be, while in the swamp lie the greatest problems of human concern. The practitioner [or in this case, designer /researcher] is confronted with a choice. Shall he remain on the high ground where he can solve relatively unimportant problems according to his standards of rigor, or shall he descend to the swamp of important problems where he cannot be rigorous in any way he knows how to describe?

While mucking it up in the ‘swampy lowlands’ can certainly present methodological challenges to research, rigor and relevance are not mutually exclusive (Reeves, 2011; McKenney & Reeves, 2012). However, as Schön points out, commitment to relevance is a matter of choice. Given all the time, energy and resources being pumped into developing and studying educational technologies, it would seem we are behoved to identify ways to design, develop and try out new possibilities that speak not to quasi-needs (e.g. “our teachers need ideas for how to use the iPads we gave them”), but to urgent ones.

TOWARD RELEVANT TEL RESEARCH WITHIN THE ZONE OF PROXIMAL IMPLEMENTATION

Much current research on TEL ultimately benefits only a small fraction of learners and practitioners, because it is conducted through high-intensity boutique projects (cf. McKenney, 2006). Such projects tend to feature substantial levels of researcher/ facilitator involvement and often lack attention for gradually withdrawing implementation scaffolds or creating/shifting ownership of an innovation into the hands of those who would continue its use. As stated above, such projects are necessary, but not sufficient to develop the understanding and tools that can yield improvements in everyday practice. To seriously explore the viability and effectiveness of TEL, research is also needed that seeks to understand the perceptions, behaviors and motives (see also Masterman, this volume) that shape the varied experiences of teachers and learners in different settings.

Shown in Figure 1, such research helps better understand the perspectives and habits of *representative/diverse teachers*. By working with diverse and representative teachers over time, it is possible to move beyond innovative one-off pilots and study how to bring about and sustain (even modest) advancements in pedagogically appropriate uses of technology. Further, it helps gain insight into *representative/ diverse learners.* Remembering that technology constitutes a mode of delivery and not, in and of itself, pedagogy, working with different kinds of learners can yield insights into the different ways that learners respond to TEL environments and different implementation choices made by teachers. Finally, the benefits of ecologically valid research contexts are enjoyed when working in *representative/ diverse settings.* Rather than working around the (for researchers often frustrating) realities and limitations of classroom and school infrastructures, this view tackles head on the work in average settings where, for example: the costs of printing are prohibitive; the school's internet firewall acts more like a prison than a filter; the teachers have extremely little curricular autonomy to make decisions about when/ how to integrate technology in their classes; how the location of computers (e.g. 3 in the classroom vs. 8 in the lab) plays a determining role on how things are implemented; or 'covering' the examination content almost singularly drives the allocation of learning time. Thus, research on TEL and the pedagogical interactions engendered by TEL, clearly attends to the actors and contexts at hand.

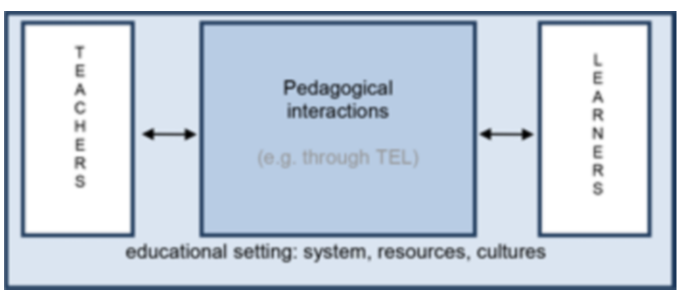

Figure 1. Research processes on TEL attending to actors and context

Studying the status quo of teaching, learning and settings, and designing TEL such that it gradually bridges from the current situation to the desired situation, is essential to developing both the knowledge and the tools required to address real needs in today's classrooms. This perspective is referred to here as the zone of proximal implementation. Vygotsky's concept of the zone of proximal development – the distance between what learners can accomplish independently and what they can accomplish through guidance or collaboration – has previously been applied to large scale reform (Rogan, 2007; Rogan & Grayson, 2003); school leadership (McGivney & Moynihan, 1972); and the mediation of educational partnerships (Oakes, Welner, Yonezawa & Allen, 1998). Similarly, others have referred to the need to pursue certain innovation goals in stepwise fashion, gradually moving from the current situation toward what is desired (cf. Sullivan, 2004). Here, the basic concept is applied to the design of TEL; but rather than focusing on what can be achieved by learners, it focuses on what can be implemented by teachers and schools. The zone of proximal implementation refers to the distance between what teachers and schools can implement independently and what they can implement through guidance or collaboration. Designing for the zone of proximal implementation means explicitly tailoring products and processes to fit the needs of not only learners, but also of teachers and schools. It additionally means planning for implementation scaffolding (e.g. honoraria or researcher co-teaching) to fade away in a timely fashion, while simultaneously developing the ownership and expertise among practitioners that will engender the desire and ability to sustain innovation. This is done, in part, through responsive (and sometimes participatory) design, fed by insights concerning learners, practitioners and context.

HOW TO DESIGN AND STUDY TEL AT THE ZONE OF PROXIMAL IMPLEMENTATION?

In their book on conducting educational design research, McKenney and Reeves (2012) identify four characteristics of innovations that are prone to successful implementation; such innovations are: value-added, clear, compatible and tolerant. During the inception, creation and testing of TEL innovations at the zone of proximal implementation, these characteristics may be considered criteria to be met. These concepts are briefly summarized below (please see McKenney and Reeves [2012] for full descriptions and justification).

Value-added innovations offer something better than what is already in place. Similar to Rogers' (2003) notion of the relative advantage, the potential benefits of value-added innovations visibly outweigh the investments required to yield them. Clear innovations enable participants to easily envision their involvement. Innovations may be *clear* through high levels of explicitness (cf. Fullan & Pomfret, 1977) through a priori specifications of procedures (cf. Doyle & Ponder, 1978) and/or interactive mechanisms whereby developers and users co-define (elements of) the innovation. *Compatible* innovations are congruent with existing values, cultures, practices and beliefs (cf. Doyle & Ponder, 1978; Fullan & Pomfret, 1977; Rogers, 2003; Zhao, Pugh, Sheldon, & Byers, 2002). They are still innovative, but the innovations and/or their underlying assumptions do not violate or reject fundamental concerns and principles of those involved. Compatible innovations are also aligned with non-changeable aspects of the educational system, such as assessment frameworks or policies (cf. McKenney, Nieveen, & van den Akker, 2006). Finally, *tolerant* innovations are those that "degrade gracefully" (cf. Walker, 2006) as opposed to yielding "lethal mutations" (cf. Brown & Campione, 1996) during the natural variation in enactment that inevitably comes along with differing contexts, resources, expertise, acceptance levels and so on. Tolerance refers to how precisely core components must be enacted for the innovation to be true to its goals, and how well an innovation withstands local adaptations.

If designing for the zone of proximal implementation includes creating innovations that are value-added, clear, compatible and tolerant, then it makes sense to consider how these characteristics can be embodied in designed innovations. Research embedded in TEL innovation development, asks questions in order to derive innovation requirements (before design), design guidelines (during prototyping) and evaluation criteria (after design) related to each of these characteristics. In attending to the zone of proximal implementation, the following kinds of questions warrant attention:

- *Value added*: Are learning practices, problems and/or outcomes improved through the use of this TEL innovation?
- *Clear*: Given the mindsets, habits and conventions in this setting, can the participants envision their participation in this TEL innovation?
- *Compatible*: To what extent is this TEL innovation compatible with the values, cultures, beliefs, priorities and contextual/system factors present?
- *Tolerant*: To what extent does the TEL innovation withstand the natural variation in actual behaviours of teachers and learners

Different methodological approaches can be better suited to certain questions. For example, observation, document analysis, questionnaires, interviews and focus groups can be useful to understand learning practices, problems and outcomes. In contrast, logbooks, as well as interviews, observations can be more useful for studying the mindsets, habits and conventions of teachers and learners. Similarly, observation, interviews, document analysis can help identify (in)compatiblities with values, beliefs and the surrounding educational context/system. Finally, observation, and document analysis can help to understand what teachers and learners actually do, whereas interviews and think-alouds can help explain why.

Investigating these characteristics in the context of TEL development requires slight variations in research focus depending on the state of TEL innovation development. Before design, research is required to understand the existing needs and context by studying various facets of the baseline situation (e.g. existing learning practices, mindsets, values and behaviours). During design, research is needed to provide empirical data about each factor that can feed prototyping and formative evaluation. After designs have stabilized and implementation scaffolds have been removed, research can measure the attained characteristics of an innovation - often, by not exclusively, by way of comparison to the baseline situation.

Table 1 offers an overview of considerations presented above. For each characteristic (value-added, clear, compatible and tolerant), the focus of inquiry is defined, with slight variations depending on the stage of TEL innovation development. In addition, methodological recommendations are given for studying each characteristic (grey cells).

Table 1. Methodological considerations for researching TEL innovations at the zone of proximal implementation

	Before design (needs/context analysis)	*During design (prototyping and formative evaluation)*	*After design (summative evaluation)*
Value-added (better than status quo)	Learning practices, problems, outcomes *in the baseline situation*	Learning practices, problems, outcomes *during use*	Learning practices, problems, outcomes *with all implementation scaffolds removed*
	Observation, learner work/assessments, document analysis, brief questionnaires (e.g. learning environment rating scales) to study enacted curriculum; focus groups and interviews to get teacher perceptions		
Clear (participants can envision their involvement)	Mindsets, habits and conventions within the classroom/ school *in the baseline situation*	Mindsets, habits and conventions within the classroom/school during use	Mindsets, habits and conventions within the classroom/school *that are sustained or changed after the innovation*
	Interviews, observations, and logbooks to track how clearly professionals understand their role and how actively they engage in it		
Compatible (compatible with values, beliefs, surrounding educational context/ system)	Values, cultures, beliefs, priorities, and contextual /system factors *in the baseline situation*	Values, cultures, beliefs, priorities, and contextual /system factors *that help or hinder implementation*	Values, cultures, beliefs, priorities, and contextual /system factors *that are sustained or changed after the innovation*
	Observation, interviews, document analysis to understand and track how alignment between the innovation and other determinants of implementation		
Tolerant (withstands the natural variation of actual use)	Actual behaviors of teachers and learners and reasons for them *in the baseline situation*	Actual behaviors of teachers and learners and reasons for them *during use*	Actual behaviors of teachers and learners and reasons for them *with all implementation scaffolds removed*
	Observation and document analysis to understand what teachers and learners actually do; interviews and think alouds to explain why		

CONCLUSION

The importance of understanding where teachers and schools are, and framing innovations to be within a reachable distance from that, has been described in TEL literature previously (e.g. Bielaczyc, 2006; Blumenfeld, 2000; McKenney & Voogt, 2012). This chapter emphasizes that more work is needed to help TEL designers and researchers do so. Research is needed to develop and refine understanding that can feed design (e.g. design principles, patterns and heuristics); and examples are needed to demonstrate how these ideas can be embodied in actual TEL scenarios. Moreover, choices are needed to focus research and development efforts on exploring new possibilities that address urgent – and not merely quasi – needs in existing classrooms.

Conducting research at the zone of proximal implementation inherently involves collaboration with practitioners (not only taking concerns seriously, but also drawing on their expertise), and appreciation of the reach and limitations of their role in determining what actually happens in classrooms. For some researchers, this can require fundamental changes in the researcher-practitioner relationship (e.g. Confrey, 2000). It may also mean learning to accept what Barab, Dodge, Thomas, Jackson and Tuzin (2007, p. 297) refer to as 'a life of compromises':

> … several interrelated tensions also emerged as problematic for our efforts yet illuminative of critical design work more generally, including (a) tensions among preexisting biases and supporting local needs, (b) tensions between empowering teachers and empowering children, and (c) tensions between local design work and more general products and theories. Further, related to the three of these is a more global tension recurrent in the prior discussion of the process of critical design work, namely, the critical design researcher's responsibility to understand the local concerns and use an appreciation of the literature to characterize the local context in a way that considers local problems but with broader significance.

While it may take time for researchers to adjust to different relationships, or to make peace with the tensions that come along with pursuing the dual aims of generating theoretical understanding while developing TEL scenarios for use in specific practical settings, the benefits of such pathways seem to warrant the effort. If we truly care about the relevance and practical applicability of research, then, alongside investments in research and development of what might be technically possible, we must invest in understanding and designing for what is realistically feasible: in the zone of proximal implementation.

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REFERENCES

Barab, S., Dodge, T., Thomas, M., Jackson, C., & Tuzun, H. (2007). Our designs and the social agendas they carry. *Journal of the Learning Sciences*, *16*(2), 263–305.

Bielaczyc, K. (2006). Designing social infrastructure: Critical issues in creating learning environments with technology. *Journal of the Learning Sciences*, *15*(3), 301–329.

Blumenfeld, P., Fishman, B. J., Krajcik, J., Marx, R. W., & Soloway, E. (2000). Creating usable innovations in systemic reform: Scaling up technology-embedded project-based science in urban schools. *Educational Psychologist*, *35*(3), 149–164.

Brown, A. L., & Campione, J. (1996). Psychological theory and the design of innovative learning environments: On procedures, principles, and systems. In L. Schauble & R. Glaser (Eds.), *Innovations in learning* (pp. 289–325). Mahwah, NJ: Earlbaum.

Confrey, J., Castro-Filho, J., & Wilhelm, J. (2000). Implementation research as a means to link systemic reform and applied psychology in mathematics education. *Educational Psychologist*, *35*(3), 179–191.

Cuban, L. (2001). *Oversold and underused: Computers in the classroom*. Cambridge, MA: Harvard University Press.

Doyle, W., & Ponder, G. (1978). The practicality ethic in teacher decision-making. *Interchange*, *8*(3), 1–12.

Fullan, M., & Pomfret, A. (1977). Research on curriculum and instruction implementation. *Review of Educational Research*, *47*(2), 335–397.

Gibbons, M. (1999). Science's new social contract with society. *Nature*, *402*, 11–18.

Knezek, G. A., & Christensen, R. (2008). The importance of information technology attitudes and competencies in primary and secondary education. In J. Voogt & G. Knezek (Eds.), *International handbook of information technology in primary and secondary education* (pp. 349–365). New York, NY: Springer.

Lagemann, E. (2002). *An elusive science: The troubling history of education research*. Chicago: University of Chicago Press.

McGivney, J., & Moynihan, W. (1972). School and community. *Teachers College Record*, *74*(2), 209–224.

McKenney, S. (2006). Book review: Internet environments for science education. *International Journal of Science Education*, *28*(1), 95–98.

McKenney, S., & Reeves, T. (2012). *Conducting educational design research*. London: Routledge.

McKenney, S., & Voogt, J. (2012). Teacher design of technology for emergent literacy: An explorative feasibility study. *Australian Journal of Early Childhood*, *37*(1), 4–12.

McKenney, S., Nieveen, N., & van den Akker, J. (2006). Design research from the curriculum perspective. In J. van den Akker, K. Gravemeijer, S. McKenney, & N. Nieveen (Eds.), *Educational design research* (pp. 67–90). London: Routledge.

Oakes, J., Welner, K., Yonezawa, S., & Allen, R. (1998). Norms and policies of enquiry-minded change: Reaching the 'zone of mediation'. In A. Hargreaves, A. Liebermann, M. Fullan, & D. Hopkins (Eds.), *International handbook of educational change* (pp. 952–975). Dordrecht: Kluwer.

OUNL. (2005). *Determinants for the failure and success of innovation projects: The road to sustainable educational innovations*. Heerlen, The Netherlands: Open University of the Netherlands Sponsored by SURF.

Reeves, T. C. (2011). Can educational research be both rigorous and relevant? *Educational Designer*, *1*(4).

Reeves, T., Herrington, J., & Oliver, R. (2005). Design research: A socially responsible approach to instructional technology research in higher education. *Journal of Computing in Higher Education*, *16*(2), 97–116.

Rogan, J. (2007). How much curriculum change is appropriate? Defining a zone of feasible innovation. *Science Education*, *91*, 439–460.

Rogan, J., & Grayson, D. (2003). Towards a theory of curriculum implementation with particular referenc to science education in developing countries. *International Journal of Science Education*, *25*, 1171–1204.

Rogers, E. (2003). *Diffusion of innovations* (5th ed.). New York, NY: Free Press.
Schön, D. (1995). The new scholarship requires a new epistemology. *Change*, *27*(6), 27–34.
Sullivan, M. (2004). The reconceptualisation of learner-centred approaches: A Namibian case study. *International Journal of Educational Development*, *24*(6), 585–602.
Tebbutt, M. (2000). ICT in science: Problems, possibilities and principles. *School Science Revie*, *81*(297), 57–64.
Walker, D. (2006). Toward productive design studies. In J. Van den Akker, K. Gravemeijer, S. McKenney, & N. Nieveen (Eds.), *Educational design research*. London: Routledge.
Zhao, Y., Pugh, K., Sheldon, S., & Byers, J. (2002). Conditions for classroom technology innovations. *Teachers College Record*, *104*(3), 482–515.

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6. INTRODUCING THE COLLABORATIVE E-LEARNING DESIGN METHOD (COED)

INTRODUCTION

Our aim in this chapter is to present the rationale and theoretical underpinnings of a particular method for learning design called CoED[1] (Collaborative E-learning Design). The method was originally developed by Nyvang and Georgsen (2007) as part of the Learn@Work project, and has since been further developed in other projects we have engaged in as a research collective. The method facilitates design of ICT-supported or networked learning activities. It divides the design process into three phases and uses specific tools and techniques in each phase. It draws on existing techniques which are often employed within iterative design processes such as card sorting and rapid prototyping; however, it entails some novel elements. Firstly, it seeks to address the gap between theoretical models of learning and actual learning designs. It does so by promoting negotiation and reflection among teachers by leading them to identify core pedagogical values, and focusing on embedding these in the actual design. Secondly, it specifically supports a collaborative approach to the design processes where teams of participants (ideally with different disciplinary backgrounds) co-develop learning designs. Thirdly, an accompanying web based software tool makes it easy to re-design the cards used as part of the method. This makes the method both scalable and applicable in different contexts.

In this chapter, we initially locate CoED within the wider theoretical landscape of learning design or design for learning (see Mor, Craft, & Maina, this volume introductory chapter); then explain the theoretical background to the method and how the CoED method works in practice. With reference to its application in three recent projects, we further illustrate how the method has been used in various settings. Following, we discuss the capacities and challenges of the CoED method, and some ideas for how we can further improve it. We discuss how the CoED method relates to other methods and tools within the area of learning design, and how it contributes to this area.

M. Maina et al. (Eds.), The Art & Science of Learning Design, 75–91.

LEARNING DESIGN

Very broadly stated, learning design is concerned with enabling educators to create, design and share pedagogically sound, high-quality designs and effective practices. Whereas early e-learning research tended to focus on the development and sharing of content and structure, the area of learning design signals a move away from an exclusive focus on delivering (digital) packaged content to students towards an increased awareness of designing for learning activity (Conole, 2007).

Even though there are many different interpretations of what constitutes a 'learning design' or a 'learning activity', we find what seems to be a general understanding that a learning design

- has certain learning objectives,
- has a sequential structure or flow,
- consists of multiple learning activities,
- and that a number of resources and learning supports are related to the design.

The relations between learning designs and learning activities are often represented as nested hierarchies, where a learning design consists of several learning activities. These relations can take on more or less formal guises. Some learning design tools are tools for combining and collecting materials and activities, and compiling these into IMS-LD or LAMS compatible packages (LAMS, eXe, CADMOS) (Goodyear et al., this volume chapter 2; Burgos, this volume chapter 10; and Daziel, this volume chapter 1) that can be shared and adapted by others and executed e.g. within an LMS (see however Burgos, 2013; Burgos, this volume chapter 10). Others are web-services or software in which one can describe pedagogical outlook, learning outcomes, sequences, activities and/or materials/supports as pedagogical patterns or various other types of templates/standards. These different formalisations of structure and activities can then be shared with others and adapted in textual and visual forms (e.g. Phoebe Pedagogical Planner, Pedagogical Pattern Collector, The Learning Designer, Compendium LD, ScenEdit (Emin et Pernin, this volume chapter 13), LdShake (Hernández-Leo et al., this volume chapter 14).

These software and web solutions are underpinned by theoretical discussion of the relations between learning designs, learning activities, learning theories, pedagogical approaches, and the particular contexts they are enacted in. The relations are important, as one of the points of learning design is to make teachers more reflective about their teaching practice. This also encompasses providing teachers with theoretically informed models of 'best practice learning designs' to promote better fits between theory and practice (Conole, Dyke, Oliver, & Seale, 2004). In this vein many theorists have worked on creating mappings of the differences and similarities between various learning theoretical perspectives (Conole et al., 2004).

As explored by de Freitas et al. (2008) more generalised frameworks and models can be useful tools in supporting practitioners' design of learning, but at the same time practitioners need to remodel these to make them useful and meaningful in their own contexts. Alternatively, such standardised frameworks run the risk of alienating and marginalising practitioners (de Freitas, Oliver, Mee, & Mayes, 2008, p. 38).

The CoED method provides guidelines for how to conduct design oriented workshops to help practitioners and designers in designing (online) learning courses, modules or other educational activities. In this way it is similar to Participatory Pattern Workshops (Mor, Warburton, & Winters, 2012) and the Carpe Diem Workshop Planner.[2] The point of departure in the CoED method is the preferences and objectives of the teaching practitioners and their pivotal role in the design process. Thus, a very important part of the CoED method is the negotiation and collaboration on establishing a shared pedagogical vision among practitioners. CoED can be viewed as what Conole (2007) terms "mediating design artifacts" like 'toolkits' (a structured resource that can be used to plan, scope and cost an activity (Conole, 2007, p. 87)). Although there is a web based software tool associated with the CoED method, this does not yield or support practitioners in generating more formalised descriptions of e.g. a course structure or sequence. Nor does it prescribe a particular level of granularity for a design (e.g. whether a more overarching vision for an educational programme or a detailed design of a particular learning activity within a module). In this sense, its capacity for reifying a design is heavily dependent on the participants' own work in using the method's resources when creating a reification of their design idea.

HISTORY AND INTRODUCTION – THEORETICAL AND METHODOLOGICAL BACKGROUND FOR COED

Royce (1970) was among the first to receive wider attention for his reflections on the process of software development. Through his work with software development in the NASA space programme he learned that software requirements were often developed along with early versions of the software, thus turning the development process into an iterative learning process for the developers.

In Scandinavia a somewhat different, but related approach to software development emerged in the 70'es and 80'es. Royce was primarily concerned with how iterations would give better quality products. In Scandinavia attention was also on the development of work contexts and working conditions ie. on the way software would change job content and working conditions (Dahlbom & Mathiassen, 1993; Larman, 2003). Thus, in the Scandinavian tradition, software development also came to involve democracy in the workplace, and involved the participation of both unions, workers, employers and computer scientists.

In education today we face challenges somewhat similar to the ones Royce experienced during the early space programme. When we design for learning conditions change - sometimes rapidly - and the interdependencies between different actors, activities and technologies are many. There is an ongoing need to find methodological approaches to learning design which will help the involved parties deal with these issues.

Drawing on the lessons learned from Royce, Dahlbom and Mathiassen and others we have been searching for tools or methodologies to support an iterative and learning oriented approach to designing for learning; one which also builds on, utilizes and develops the knowledge of all involved parties. Here we draw on Wenger and his social theory of learning (Wenger, 1998) to maintain the focus on social practices and development. According to Wenger, a social theory of learning must include community, practice, meaning and identity. Negotiation of meaning within a community is the core learning process, and negotiation is defined as a process of participation and reification. This means that learning in an organization - or a team of designers - calls for communicative participation in the process and for ways to develop tangible outcomes of the process.

COED PHASES AND PRINCIPLES

The CoED method facilitates a design process by following five overarching principles, and splitting the early design process into three phases.

Principles – the CoED method:

1. Facilitates conversations about e-learning design
2. Structures conversations about e-learning design
3. Produces design specifications and/or actual designs rapidly
4. Involves e-learning experts, domain specialists and future users of the e-learning design
5. Involves at least two people in the design process

The principles are relatively straightforward and act as guidelines for the overarching purpose of the CoED method: To support structured dialogues and concrete design activities among a diverse group of participants (more than two), and ideally with participants from different domains. Following principle number four, the design process ideally involves learning experts, domain specialists and future users of the learning design.

Phases

1. Focus the e-learning design process (presentation).
2. Identify overarching values and design principles (card sorting and selection through a process of prioritising)

3. Specify design (card sorting and design)

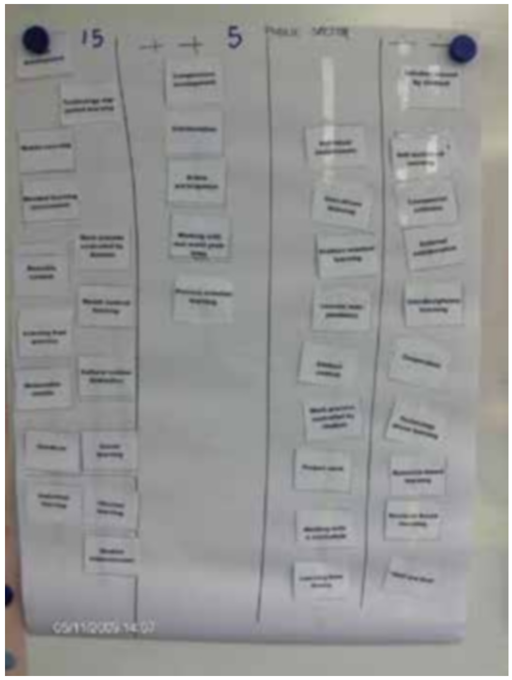
To give an overview of the method we briefly describe the purpose of the three phases. The first phase is usually conducted as an “expert” presentation, whereas the other two phases involve all participants in different card sorting and design activities. However, the exact running and contents of each workshop can and should be tailored depending on purpose and context of the workshop, as we return to in the case examples.

First Phase

The initial phase of focusing the e-learning design process is intended to be an “expert” presentation. The presenter, who is usually one of the workshop facilitators, may give an introduction to a topic relevant for the scope of the workshop e.g. outlining differences between more content oriented and more dialogue-oriented teaching approaches or the functionalities of a certain learning management system. The purpose is to establish common ground before entering the design phase, so the initial presentation should be an introduction into pertinent questions related to the scope of the particular workshop.

Second Phase

In the second phase participants are tasked with a card sorting exercise. From a number of value cards with value statements or learning orientations the participants need to gradually choose the values and principles that should guide their own design (see Picture 1 for an example). Value statements can be e.g. “collaborative learning”, “skill and drill”, “open educational resources”, “reflection-on-action”, or the like. Often value cards will reflect contradicting or opposing values e.g. collaborative learning vs. individual learning, content vs. process, teacher control vs. student control. Value cards are often designed to be open ended, ambiguous or synonymous to prompt participants’ reflections and discussions, rather than representing clear-cut learning orientations. At the end of the phase, the participants will have to choose a maximum of e.g. five value cards, which they believe are the most important values and design principles. The purpose of the phase is to engage the participants in discussions and reflections on their educational and pedagogical values or principles. Thus, the activity of the phase aims at facilitating and structuring conversations about e-learning design. The particular organisation of the phase can vary and e.g. be split into fewer or more sub-phases of gradual refinement of the values. Likewise, different categorisations and visualisation can be used.



Picture 1. Example of value cards

Third Phase

The third and final phase is a more concrete design task where participants use a number of design cards within three categories (see Picture 2) to design the outline of a course, a module or activity. Usually posters and pens are provided, as for participants to place the cards on the poster, add extra cards they feel are missing, and to present their final design as a visual presentation. The design cards are grouped into three categories, where we have often used a distinction between: Resources, Learning Activities, and Infrastructure. Resources can be e.g. e-books, blogs, teachers, case descriptions or articles. Learning activities can be discussions, blogging, collaborative writing or supervision. The final category is (technical) infrastructure, which can be intranet, wireless network, learning management system, location based services, etc. The purpose of the phase is to engage participants in the concrete design of an outline for a course, module or activity and use the design cards to prompt reflections and visualise relations between e.g. resources and activities or the pedagogical intentions of using a blog for a particular activity. The cards are there to remind participants of the vast amount of resources and activities which can be part of a learning situation, and how these should be facilitated technically.

Picture 2. Examples of design cards

To support the practical work of running workshops based on the CoED-method, an online CoED Card generator has been developed (see http://old.ell.aau.dk/coed). The card generator produces a text document (RTF) with design cards and a header card. The design cards fall into three categories, where users can choose other categories than activities, resources and infrastructure. Under each of these categories, users can create as many cards as they wish (e.g. activities such as blogging, writing, discussing etc.).

We present practical examples of how different CoED-workshops have been organised, adapted and facilitated, e.g. in terms of how value cards and design cards have been designed by the facilitators, and how the overarching goals of the workshops have been framed (for a presentation of the first CoED workshop conducted, we refer to Nyvang & Georgsen (2007)).

CASE 1: EATRAIN2 – A EUROPEAN PROJECT ON EDUCATION AND TRAINING

Context

A CoED workshop was carried out in relation to the EU-funded research project "Innovative Enterprise Architecture Education and Training Based on Web 2.0 Technologies" (EATrain2). The objective of the work package, in which the authors were primarily involved, was to develop a Problem Based Learning methodology capitalising on web 2.0 technologies. The learning methodology would then feed into specific course production and platform development. Following the workshop, three online pilot courses on "Enterprise architecture" (designed for business, the public sector and academia respectively) were developed, run and evaluated. As part of the learning methodology we conducted a CoED-design workshop with the intention of producing a number of preliminary course designs primarily focused on the use of web 2.0 technologies and appropriation of problem based learning principles (Tambouris et al., 2012).

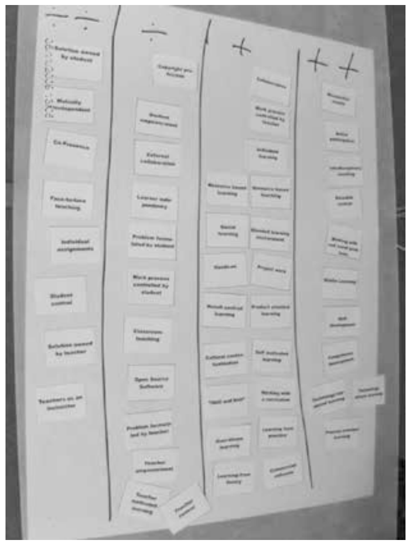
Scope & Participants

We customised the design and value cards in relation to web 2.0 and main principles of PBL. In relation to PBL we designed some of the value cards as specifically reflecting tensions between student and teacher control e.g. whether problems would be given to students or identified by students (Ryberg, Glud, Buus, & Georgsen, 2010). Likewise, design cards were designed to reflect web 2.0 activities, resources and technologies, such as micro-blogging, podcasting, geo-tagging, and social bookmarking. The workshop involved ten participants including the facilitators. These were project members from the different partner institutions of which some were teachers or content experts, others working with development of the platform, and some were project managers.

Format

The workshop lasted approximately four hours. In the first phase of the workshop we introduced key issues in the pedagogical design of web 2.0 and problem based learning. In the second phase the participants were divided into two "course design" groups (private sector and academia with each two sub-groups). In these groups participants conducted the first card sorting exercise using the value cards. The participants were initially asked to put the various value cards into four groups: 1) the most important, 2) the important, 3) the less important, and 4) the unimportant. The four categories were marked by ++, +, -, -- on an A1 poster (Picture 3). After this we asked participants to remove the cards from the categories less important and unimportant, and repeat the process of prioritising the cards thus reducing the number of cards to be kept in the most important-categories. In the third cycle the subgroups within the private sector and the academia met and compared what they had placed in the categories "most important" and "important". In the fourth and final cycle, the two groups had to re-negotiate and agree on five overarching values to guide their more specific design.

In the third phase the participants continued the work in two design teams. Each group had a facilitator for asking critical questions and supporting groups in formulating a design which reflected the five core values. These were taped to a header card placed on the A1 poster which participants used to discuss, and place their design cards. The design cards were made using the categories: resources, activities and infrastructure. The design results or preliminary designs can be seen from Picture 4 below. These tentative designs, however, were not the most valuable outcomes of the workshop. One problem with the workshop was that only few of the participants would actually be teaching the courses themselves, and therefore had difficulties going into more specific discussion of the course designs (particularly the contents, but also the preferred teaching style etc.).



Picture 3: Poster for sorting value cards

Picture 4. Design results from EAtrain workshop

Outcomes of the Workshop

As stated above the designs emerging from the workshop were not as detailed as we had initially hoped for. However, the contradictions and tensions identified by the participants during the CoED-workshop had a larger impact on the further process of designing the courses. For example: Would it be possible to carry out a course framed within a problem based learning-approach without a teacher/facilitator? Were there contradictions between the intentions of adopting PBL and web 2.0 learning principles and institutional assessment practices? If students were assessed individually would they collaborate? These became ongoing topics of attention, and even though some of the contradictions were difficult to solve in practice they were helpful in ameliorating or reducing the tensions, as teachers and course designers were conscious of these potential problems. Likewise, it became apparent during the discussions and design phases that the partners held very different ideas of how their courses would be run and supported. These differences had not previously been visible or articulated among the partners. Equally valuable were the participants' discussions of PBL and their different conceptualisations of how much ownership could be relegated to students, and what was the role and responsibilities of the teacher.

CASE 2: UNIVERSITY COLLEGE SOUTH - AN ORGANISATIONAL DEVELOPMENT PROJECT

Context

University College South is a young institution with five campuses in five different cities in the southern part of Denmark. In 2012 it was decided in 2012 that all educational programmes should use the same VLE, and task force within the organisation drafted an implementation plan. Not only would some study programmes start using a new VLE, most programmes would also have to switch from version 1.0 to version 2.0 of the same VLE, a considerable change in terms of functionality, interface, and degree of local adaptability. As part of this implementation plan, a series of workshops were planned for all teaching staff in all study programmes. The idea was to involve teaching staff in the implementation process in order to create a sense of ownership and also develop new ways of teaching with ICT in the organisation. For this purpose, the CoED method was used in eight workshops with participants from 11 different study programmes. The envisioned starting point was to involve the teaching staff in learning design by focusing on the teaching and learning activities, rather than on the functionality of the technology.

Scope and Participants

Given the fact that a specific VLE had already been chosen, this was to a certain degree integrated into the workshop design, namely in the first phase. An 'expert' presentation opened all workshops, showing different ways of using a VLE for teaching and fitting it into different learning philosophies. The number of participants in the workshops varied from 8 to 55. In most cases, the participants came from only one study programme. In some workshops, management would take active part in the design activities (e.g. head of studies), and in others the administrative staff had been invited to participate as well as teaching staff.

Format

Most workshops took place in three hours, and only with very large groups did we manage to get more time for the work. We worked through the three phases, and at the end of phase 1, participants were asked to formulate specific design or development projects they were interested in. We did this in an effort to engage participants, to make sure that their point of departure was a teaching or learning situation they wanted to improve or develop, and finally to ensure that the participants finished the workshop with a useful product or outcome. Examples of such design projects were:

- Use of blogs and wikis in teaching
- Creating more interactivity in on line-courses
- Use of portfolio during work placement periods
- Video as a tool for documentation and reflection

Although the design projects had both technological and learning oriented aspects, we encouraged participants to put emphasis on the learning and teaching during the design work, and to be as specific as possible when developing scenarios for future teaching.

Outcome of the Workshops

The first phase basically showed two kinds of problematic behaviour across the workshops. One category of workshops had participants that appeared not to be able, willing or motivated to articulate the underlying assumptions of the current practices, whereas another category of workshops had participants that appeared to be quite content discussing general conditions for their work (the government funding; the level of skills and knowledge of their students, etc.). We see both categories of behaviour as ways of ‘dodging the bullet’ meaning that by either ignoring the foundation or by pointing to matters outside their own control the participants never fully assumed ownership of the implementation process or the appropriation of the technology in question in phase two and three. Some workshops did, however, show more ability and will to engage in deeper discussions about basic values and assumptions. Unfortunately we cannot explain why the workshops came out so differently (apart from differences in the history and culture of workshop participants).

The fact that in most cases the participants came from the same study programme, had the unforeseen consequence that some of the underlying assumptions about the particular study programmes, its students, or the 'nature' of the content, were never questioned or even articulated. This was partly a consequence of having too homogeneous groups and not enough interdisciplinarity in the design teams, and partly an illustration of the culture in the different groups of colleagues.

Another challenge in this project related to carrying the design ideas into the next stage of the implementation process. Not everyone in the IT-department were knowledgeable of the overall plan, so even when IT-people took part in the workshops (which only happened in some cases), we were not convinced that the ideas and needs described by the teaching staff in the design sketches were fully understood by the technical staff. The tangible outcomes from the workshops (see examples of designs in Picture 5 below) were meant to ensure connection between the rapid prototyping process and the technology development/appropriation later; however, we were not convinced that there was sufficient time and resources to support the full development of all design ideas.

Picture 5. Design sketches

CASE 3: TEACHERS INTEGRATING WEB 2.0 IN UNIVERSITY TEACHING

Outcome of the Workshops

This CoED workshop was part of a PhD project aiming to study ways teachers integrate web 2.0 based activities into their teaching, and to support and inspire them. The workshop was conducted only for teachers at the Faculty of Social Science at Aalborg University (AAU). The overall aim of the workshop was to raise teachers' awareness of possibilities for integrating web 2.0-mediated activities, and to let the teachers collaboratively develop ideas for how web 2.0 activities could be integrated into course-related PBL settings.

Scope and Participants

Based on experiences from former workshops the facilitator knew that there could be a potential gap between the designs ideas produced during a CoED workshop, and then the actual implementation of these (as also discussed in case 2). This had been taken into consideration, and the intention was to look at the CoED workshop as part of a longer design process. Thus, an extension of the CoED method was developed, which has been further explained in (Buus, 2012). The participating teachers who signed up for further design-work after the CoED workshop, were supported in the development of their ideas and the transformation of these into actual course designs.

Only teachers were invited to the workshop as they were the target audience of this case. One person from the IT department observed the workshop process, but did not interact with the teachers in the workshop. She wanted to watch the workshop process to be able to follow up technical ideas afterwards if needed. Approximately 160 teachers at the Faculty of Social Sciences were invited to participate. Twelve out of the 160 teachers signed up for the workshop, but only seven actually turned up on the day of the workshop.

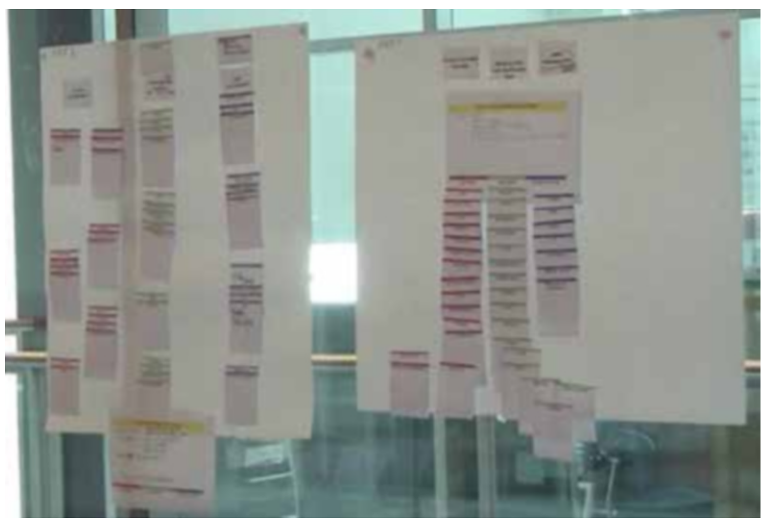
Format

The duration of the workshop was 6 hours. In the first phase participants were introduced to different definitions and teaching practices involving PBL and social media. Researchers within the area of social media and PBL were invited to make a presentation.

Phase 2 began by defining and negotiating pedagogical values within four groups. This phase became particularly interesting, because although the participants belong to the same organisation and even the same faculty, they engaged in a lot of negotiation and discussion on PBL in an AAU context. All the value cards from the first iteration that were placed in "most important" and "important" were subsequently brought into two groups, who then had to agree on only three shared pedagogical values to base their learning design on.

In the third phase the two groups worked on developing a course design for a prototypical course (for on-campus students with around 160–200 students). The output of this phase was two designs based on both new ideas, but also inspired by activities already integrated by some of the teachers in their courses.

Picture 6. Value cards discussion



Picture 7. Designs on posters

Outcome of the Workshop

One of the challenges in this workshop was to inspire participants to adopt elements from the prototypical course design into their own teaching context. The workshop generated many ideas and seemed to inspire participants. However, the step from 'prototyping' to actually implementing the design is missing. This has been a general experience with CoED. To cope with that issue the facilitator did a follow-up on the workshop offering further technical and pedagogical assistance for teachers. In the follow-up workshops there were three teachers with different ideas of web 2.0 activities, who wanted to make their design ideas more tangible. In collaboration with the researcher, the teachers developed new learning designs inspired from the dialogue during the workshop.

We would argue that the workshop provided the basis for rethinking the learning practice for some teachers. Only three teachers were participating in the follow-up process of the workshop, but others from the workshop may have been inspired and built in web 2.0 mediated activities into their teaching. In later interviews, the teachers we followed stated that the support following after the workshop was important in making the learning design a reality in their teaching practice.

CONCLUDING DISCUSSION

The sum of experiences with the CoED method shows that within half a day, practitioners often manage to create relatively detailed preliminary designs (prototypes), while also negotiating a shared pedagogical vision for such a design. Additionally, they often find that they have more different pedagogical values and beliefs than anticipated before the workshop. Engaging participants from different target groups gives the dialogue and negotiation a broader variety of perspectives on the learning design process. In practice, as can be seen from the cases, it can however be difficult to ensure a mixture of tutors, teachers/domain experts, ict- or online learning specialist, managers or who might be the relevant actors. In the first case there were too few teachers present (those who would actually be teaching the course), whereas in the second case a large homogenous group of teachers made it difficult to articulate and challenge the underlying assumptions in the programme under development. However, the CoED method can be one way of engaging with different types of practitioners (teachers, managers, it- or online learning specialists) on designing for learning. Moreover, the CoED method provides practitioners with a space for discussing their values, design concrete learning activities, and representing these in a very flexible, yet structured manner. Therefore, it introduces an adaptable and scalable design concept that allows for different levels of detail in terms of the resulting design, while maintaining a strong focus on the negotiation of shared pedagogical core values among a potentially diverse group of participants.

The scalability and adaptability of the method we view as both a strength and a weakness. It does not prescribe a certain level of granularity, but can be employed both to generate visions and plans for a whole online programme. Also it can be used to plan a very specific learning activity within an established course. In this way it does not generate a design as specific as e.g. the Carpe Diem Planner, nor does it directly entail that designs are implemented in a software system and will yield e.g. an IMS-LD or LAMS design. This can be seen as a weakness in the sense that it is at times left to the participants to further detail and reify their design proposal in a more concrete format (e.g. designing the course in Moodle or as a set of distributed tools). As can be seen from the third case (teachers integrating web 2.0 activities into a course design) the teachers stated that the support following the workshop was important in making their learning design a reality. Equally, in the original Learn@work project the initial designs were also subject to further discussion and iterations as part of the larger project. However, as we see in case 1 and case 2 it can at times be difficult to know how the workshops have more specifically impacted and materialised in a final course design. But it should also be noted that we view the CoED-method as one step in longer and potentially more complex development processes (whether or not we as researchers can follow this). A fruitful avenue for further work would be to combine CoED-workshops with other tools and methodologies e.g. having participants working on the basis of pedagogical patterns, produce storyboards, implement design ideas and activities in CADMOS, ScenEdit or LdShake, as to create stronger reifications of the designs.

However, we also view the lack of prescribed structure and granularity as a strength, as it may invite or allow some more overarching debates to emerge. In all cases it was evident that practitioners held different pedagogical ideals and these differences or variations often surface during the CoED workshops. Particularly in the second phase where the overarching values are negotiated. In design processes involving the development of designs in which multiple actors and professional backgrounds are engaged, we believe that this can open up to negotiation of perspectives and understandings which could otherwise have generated tensions between the actors, had they not been brought together. Our experiences also highlight that 'course designs' and higher level designs for learning are complex constructs which involves both institutional policies, pedagogical values, distribution of labour and responsibilities. In the EAtrain project it was clear that different assessment formats and institutional policies among the partners shaped how a problem based learning course could be run. In the UC Syddanmark case all kinds of concerns surfaced at both an institutional, as well as a national policy level, and it seemed that not all teachers were equally willing to assume responsibility for the implementation project. This can in one way be seen as 'dodging the bullet' and resisting the purpose of the workshop, but on the other hand it could also signal that teachers (or other actors) have legitimate concerns around the implementation processes and the potential changes it could bring about in their working life and responsibilities. During workshops we have experienced how different and sometimes conflicting views of pedagogy and learning emerge among practitioners or between practitioners and the institution's pedagogy. We have seen how institutional demands are curtailing or enabling particular pedagogies, and we have been involved in larger scale organisational change processes that might be part of reshaping participants' professional life. These experiences make us ask whether the field of learning design or design for learning could further benefit from discussions and insights from the Scandinavian Tradition. We are wondering whether we should not only be concerned with the quality of the particular product or learning design, but also on how the designs, tools and methods might be part of shaping working conditions and contexts for practitioners.

NOTES

[1] Please refer to: http://www.old.ell.aau.dk/coed/
[2] Please refer to: http://www.ld-grid.org/resources/methods-and-methodologies/carpe-diem

REFERENCES

Buus, L. (2012). Scaffolding teachers integrate social media into a problem-based learning approach? *Electronic Journal of e-Learning 2012, 10*(1), 13–22. Retrieved from http://www.ejel.org/issue/download.html?idArticle=175

Conole, G. (2007). Describing learning activities; Tools and resources to guide practice. In H. Beetham & R. Sharpe (Eds.), *Rethinking pedagogy for a digital age: Designing and delivering e-learning* (pp. 81–91). New York, NY: Routledge.

Conole, G., Dyke, M., Oliver, M., & Seale, J. (2004). Mapping pedagogy and tools for effective learning design. *Computers and Education*, *43*(1), 17–33. doi:10.1016/j.compedu.2003.12.018

Dahlbom, B., & Mathiassen, L. (1993). *Computers in context: The philosophy and practice of systems design*. Cambridge, MA: Blackwell Publishers.

de Freitas, S., Oliver, M., Mee, A., & Mayes, T. (2008). The practitioner perspective on the modeling of pedagogy and practice. *Journal of Computer Assisted Learning*, *24*(1), 26–38.

Larman, C. (2003). *Agile and iterative development - a managers guide*. Boston, MA: Addison Wesley.

Mor, Y., Warburton, S., & Winters, N. (2012). Participatory pattern workshops: A methodology for open learning design inquiry. *Research in Learning Technology*, *20*. doi:10.3402/rlt.v20i0.19197

Nyvang, T., & Georgsen, M. (2007). *Collaborative e-learning design method (CoED) (No. 12)*. e-Learning Lab Publiation Series (p. 25). Aalborg University. Retrieved October 31, 2009 from http://www.ell.aau.dk/fileadmin/user_upload/documents/publications/ell_publication_series/Collaborative_e-learning_design_method_no._12.pdf

Royce, W. W. (1970). Managing the development of large software systems. *In proceedings of IEEE WESCON*. 26 Los Angeles. Retrieved from http://leadinganswers.typepad.com/leading_answers/files/original_waterfall_paper_winston_royce.pdf

Ryberg, T., Buus, L., & Georgsen, M. (2012). Differences in understandings of networked learning theory: Connectivity or collaboration? In L. Dirckinck-Holmfeld, V. Hodgson, & D. McConnell (Eds.), *Exploring the theory, pedagogy and practice of networked learning* (pp. 43–58). New York, NY: Springer New York.

Tambouris, E., Panopoulou, E., Tarabanis, K., Ryberg, T., Buus, L., Peristeras, V., … Porwol, L. (2012). Enabling problem based learning through Web 2.0 Technologies: PBL 2.0. *Educational Technology & Society*, *15*(4), 238–251.

Wenger, E. 1998. *Communities of practice – learning, meaning, and identity*. New York, NY: Cambridge University Press.

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7. DOUBLE LOOP DESIGN

Configuring Narratives, Patterns and Scenarios in the Design of Technology Enhanced Learning

INTRODUCTION

A critical role for Learning Design is to improve education, but we need to first ask ourselves: what is the role of education? Dewey (1938/2007) argues that it is to provide experiences that promote growth. Not just in the course of the experience itself, but in setting up the conditions for further growth through future experiences. It is within this broad definition of education that our teachers find themselves confronted with the challenging task of preparing people for a complex and demanding world.

Arguably, such a mission requires educators to perceive themselves, and be acknowledged by others, as designers of learning and not merely as providers of content. Here, we perceive design both in the sense of Herbert Simon, as "changing an existing state of the world into a desired one" and in the view of Donald Schön as a "reflective conversation with the materials of a conversation". Schön (1992a) draws many parallels between teaching, learning and design:

> When we attend to what we know already, appreciating the artistry and wisdom implicit in competent practice, believing that by reflection on that practice we can make some of our tacit knowledge explicit, we take on a "reflective turn", that leads us to see students and teachers (at their best) as participants in a kind of reflective practice, a communicative and self-reflective practice of reciprocal inquiry.

Schön concludes:

> From the perspective of designing as learning and learning as designing, the teaching/learning process could be seen, at its best, as a collaborative, communicative process of design and discovery.

If we want education to be responsive to the ever-shifting environment we live in, and address the challenge of providing learners with experiences that foster continuous growth, there is a clear imperative for reconceptualising education as learning design

M. Maina et al. (Eds.), The Art & Science of Learning Design, 93–104.

- "the act of devising new practices, plans of activity, resources and tools aimed at achieving particular educational aims in a given situation" (Mor and Craft 2012).

Embedding the ideas of learning design into a framework of teacher inquiry produces the notion of *Design Inquiry of Learning* (DIL): a projection of design science into realistic settings. DIL combines an inquiry-based learning approach with a design-based scientific paradigm. This notion resonates with other considerations of effective learning, for example, in networked learning which promotes a reconfiguration of the relationship between the learner and the teacher (Dirckinck Holmfeld et al., 2012) and in the body of work surrounding inquiry based learning (Littleton et al., 2012).

Mor, Craft & Hernández-Leo (2013) posit that the grand challenges of learning design can be summarised in three words: language, practices, and tools. First, language is identified as the representational fabric - verbal, graphic, formal, computational and other – in which we formulate, share, and critique design knowledge in education. Second, knowledge-creation and their corresponding pedagogical practices are encapsulated within design knowledge, although we need to ensure we have valid, robust and agile practices of design. Third, we need tools that embody and support these practices and allow us to efficiently manipulate, share, store and retrieve constructs in these languages.

The SNaP! (Scenarios, Narratives and Patterns) framework (Mor, 2013) offers a contribution in terms of language and practices. Although it does not refer to any particular tool it is not tool-agnostic. It instead defines a set of constraints, requirements and preferences on a range of tools. This framework is somewhat abstract, and needs to be manifested through concrete methodologies of action. Two methodologies have been developed and tested extensively: the Learning Design Studio methodology (Mor & Mogilevsky, 2013a; 2013b) and the Participatory Pattern Workshop (Mor, Warburton & Winters, 2012). The first is a platform for action, the second emphasises collaborative reflection. Together, they fulfil Schön's ideal of collaborative, communicative, reflective conversations with the materials of a situation.

This chapter presents the framework, examines its reflection in the Learning Design Studio (LDS) and Participatory Pattern Workshops (PPW), and considers a future scenario in which the two may be combined as a basis for professional development.

THE SNAP! BUILDING BLOCKS

The SNaP! Framework addresses the need to represent, share, reuse and manipulate design knowledge in education. It consists of three representations - design narratives, design patterns and design scenarios, and a set of practices for constructing and using these representations. Mor et al. (2014) offers a rich set of examples of narratives, patterns and scenarios.

Design Narratives

Design is a messy business. As Schön (1992a) and Béguin (2003) note, designers introduce innovations into a situation based on their reading of the situation, but in doing so, change the situation itself, and inevitably cause different effects than they expected. Schön (1992b) stresses that design knowledge is predominantly tacit, knowledge-in-action. As Cross (2006) further explains:

> Essentially, we can say that designerly ways of knowing rest on the manipulation of non-verbal codes in the material culture; these codes translate 'messages' either way between concrete objects and abstract requirements; they facilitate the constructive, solution-focused thinking of the designer, in the same way that other (e.g. verbal and numerical) codes facilitate analytic.

How do we make it explicit? How can the designer make sense of her experience, draw conclusions from it and use them to inform future experiments? Design narratives harness the innate epistemic power of story-telling for this purpose.

Jerome Bruner (1991) has shown that narrative is a fundamental epistemic force. We weave our experiences into stories in order to extract and share meaning from them. Design narratives leverage this force, but provide structure and rules which turn the outcome into a scientific construct. Design narratives provide an account of the history and evolution of a design over time, including the research context, the tools and activities designed, and the results of users' interactions with these. They include an honest portrayal of the challenges encountered along the way, and how these were resolved. In order to adhere to scientific standards, design patterns need to be clearly traceable to data and explicit about their methods of analysis. In contract with "natural" or literary narrative, they also need to state their conclusions openly so that these are open for scrutiny. Mor (2013) outlines criteria for validity of design narratives, and selection rules for including them in a body of evidence.

Design Patterns

Design narratives offer thick descriptions of innovations, but they are often too specific to lend themselves to efficient transfer to novel challenges. Design patterns fill this gap by offering a "grounded abstraction" of design knowledge distilled from design narratives. Design patterns originate in the work of Christopher Alexander and his colleagues in the theory of architecture (Alexander, 1977). A design pattern describes a recurring problem (or design challenge), the characteristics of the context in which it occurs, and a possible method of solution. Patterns are organized into coherent systems called pattern languages where patterns are related to each other. The core of a design pattern can be seen as a local functional statement: "for problem P, under circumstances C, solution S has been known to work".

Design Scenarios

Design scenarios borrow the form of design narratives, and adapt it from an account of documented past events to a description of imagined future ones. Design scenarios retain the same basic components that constitute design narratives: context, challenge, theoretical framework, events and actions, results and reflections. However, these elements reflect a hypothesis about possible future states of the world. The context describes an existing situation, which is perturbed by the introduction of new material, social and intentional elements such as new technologies, new practices, or new objectives. Consequently, the challenge component may describe an existing conflict of forces, which is altered by the introduction of new contextual elements. Alternatively, it may consist of altogether new requirements arising from the reconfiguration of forces, such as the satisfaction of novel objectives. At the heart of a design scenario are a sequence of actions the protagonists may take to achieve their objectives, events which they may encounter and their reactions to these, and finally – the ensuing results of this sequence. These actions, event, and consequent results are afforded or driven by the qualities of new artefacts introduced into the context. Thus, they express a design claim: that introducing such artefacts into such a context may induce such results. However, this claim is stated in a thickly grounded form, submitting it to elaborate scrutiny.

LEARNING DESIGN STUDIO (LDS) AND PARTICIPATORY PATTERN WORKSHOPS (PPW)

The combination of design narratives, patterns and scenarios has been used successfully in two approaches: the Participatory Pattern Workshop (PPW) methodology for collaborative reflection and the Learning Design Studio methodology for training educators as learning designers.

Participatory Pattern Workshops

The PPW methodology (Mor, Warburton & Winters, 2012), also called the "Participatory Methodology for Practical Design Patterns", is a process by which communities of practitioners can collaboratively reflect on the challenges they face and the methods for addressing them (Figure 1). This methodology has been initially developed in a blended context, through series of face-to-face workshops interleaved with on-line collaboration (e.g. Mor, Mellar, Pachler, & Daly, 2010). However, it has also been used in purely online configurations (e.g. Warburton, 2009). The outcome of the process is a set of design narratives, design patterns and design scenarios situated in a particular domain of practice. At the heart of this process are three linked collaborative reflection workshops:

- Design Narratives Workshop, which provokes collaborative reflection among practitioners by a structured process of sharing stories.

- Design Patterns Workshop, where participants use comparative analysis of design narratives to define proto-patterns and elaborate these by articulating the problem, context, core of the solution and related patterns.
- Design Scenarios Workshop, in which participants put patterns to the test by applying them to novel problems in real contexts.

These workshops where supported by a set of activity patterns (the "support toolkit").

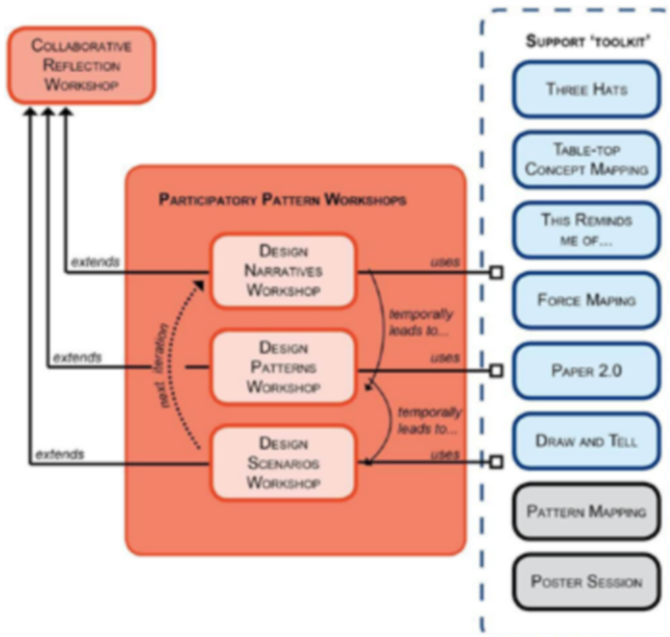

Figure 1. An overview of the participatory pattern workshop methodology detailing the three core collaborative reflection workshops and the support toolkit providing a range of scaffolded activities (from Mor, Warburton & Winters, 2012)

Learning Design Studio

The Learning Design Studio (LDS) is a collaborative, blended, project based framework for training teachers in effective and evidence-based use of educational technology (Mor & Mogilevsky, 2013a; 2013b). This approach is modelled after the tradition of studio-instruction in arts and design disciplines (Green & Bonollo, 2003), and reflects a pedagogy of Design Inquiry of Learning (DIL). In the studio model, the main activity of a course is the students' continued work on design challenges in a defined domain of practice. Students typically work in groups. They identify an educational challenge, research it, and devise innovative means of addressing it. The course instructor guides the students through the process, and classroom sessions are mostly dedicated to group work and public review of design artefacts.

The course instructor guides the students through the process, and classroom sessions are mostly dedicated to group work and public review of design artefacts. The LDS uses scenarios, narratives and patterns - but in a different sequence and a different mindset than PPW. Whereas the objective of PPW is reflective and analytic, the LDS is a site of experiential learning through educational innovation (Figure 2). Participants first conceptualise their project plans in the form of a draft scenario (*imagine* and *investigate* phases). They then consult existing design patterns and design principles (Kali, 2006) and consult the relevant scientific literature (*inspire* phase) to elaborate their scenario and draw out potential solutions to the educational challenge they have chosen (*ideate* phase). They proceed to *prototype* their proposed solution and *evaluate* it, and conclude the process by writing *reflective* design narratives. When used as an educational format (e.g. in a course or CPD) this is typically where the process ends – although in principle participants could flow straight into a new cycle of inquiry.

Figure 2. The cyclical 'Design Inquiry of Learning' approach that forms the Learning Design Studio methodology

RESULTS

The PPW methodology has been used with experts from a range of domains that have included feedback and assessment processes, teaching in virtual worlds, collaboration, and managing digital identity. In each case the full cycle of workshops have been completed and some of these outputs have been archived on the pattern language network site, which lists over a hundred design narratives, close to thirty design patterns and thirteen plus scenarios. The published work has included the formative e-assessment strand (Daly, Pachler, Mor, & Mellar, 2010; Mor, Mellar, Pachler, & Daly, 2010), which produced nine design narratives, five of which were selected for publication, and 10 patterns gathered during the JISC funded FEASST project. Later work spread into the domain of virtual worlds. During the EC funded 'MUVEnation' project, teachers and educational researchers were brought together in an online space and produced 28 design patterns, over 80 case stories and more that 20 design scenarios in the use of 3D virtual worlds for learning and teaching (Warburton, 2009). Finally, during the 'Rhizome' project, a group of experts were brought together in the production of 11 design patterns and more than 25 case-stories in the domain of digital identity management (Warburton, 2013). Recently, the methodology has been used with promising results by the ML4D project in the domain of mobile learning for development.

In summary, the PPW has been an effective methodology in two key ways: first, in the successful abstraction of design knowledge from narratives into a design pattern format; second, in bringing communities of experts together and, through an intensive process of reflection, creating a transformative experience for all participants. Yet the intensive nature of these workshops brings with it a substantial overhead in the form of commitment and sustained effort. This effort is required from the facilitators - to scaffold and thread participant activity through each of the workshop stages - and also from the participants who are required to work through cases and problems that span the synchronous workshop meetings. What has become apparent is that production of concrete design solutions, articulated as design scenarios has been consistently difficult to achieve. The low numbers of design scenarios that are fully worked through at the end of the PPW process has revealed some of the difficulty in the application of design patterns to solve new real world problems. This has reflected some of the difficulty where oscillations between design thinking and its' relationship to practice have been required.

The learning design studio format has been trialled in six different course settings: two at the Technologies in Education postgraduate programme at the University of Haifa during the academic year 2010–2011, one in the Open Learning Design Massive Open Online Course (OLDS MOOC), two in the HandsonICT project MOOCs and in one course in The Open University's (OU) Master in Open and Distance education programme. The University of Haifa courses both ran for 13 weeks in a blended format (2 hours face time, 4 hours independent study). The first included 22 students, who split into 9 project groups. The second included 17 students in 6 project groups. All students passed, and all projects were completed, most to a high standard. The OLDS MOOC (http://olds.ac.uk) ran for nine weeks, from January to March 2013. Evaluation of the OLDS MOOC reveals that while many participants found the experience fruitful, informative and rewarding, the collaborative project aspects of the MOOC did not materialise as planned (Cross, 2013; McAndrew, 2013). Participants did engage with design patterns, design narratives and design scenarios; about 60 scenarios were published by participants in week 2, some with over 20 comments from peers. About 25 narratives were published by participants in week 8, and again – some received more than 20 peer comments. However, this engagement by the participants was predominantly as isolated experiences, rather than as a cohesive language and a system of practice within a community. Consequently, the

HandsonICT project adopted a “lightweight” version of the methodology, relaxing the collaborative aspects and reducing the complexity of the representation that participants were required to use and produce (Stoyanov et al., 2014). The OU case was a seven week block out of the 30 week MA course “openness and innovation in elearning”. The course had 70 students registered and was taught fully online with the students expected to commit 14 hours a week. The students were assigned to 11 project groups based on their choice of project subject. The post course evaluation revealed the majority of projects as being of outstanding quality.

Reflecting on the evaluations of the LDS process we find some similarities with the comments on the PPW. For example, during the OU course, while many students reported an enriching and rewarding experience, most noted the intensity and demanding nature of this block of study. The LDS process is a demanding one - both for the students and the tutors. It requires the preparation of a varying amount of scaffolding depending on the particular context i.e. whether the course is delivered in a blended or entirely online mode. Many students were unsettled by the unfamiliar pedagogical process. The nature of the LDS methodology foregrounds innovation and questioning of a problem space and this forms a critical part in eventual success of the LDS cycle. In the design studio approach this also means that ‘getting lost’ becomes part of the rite of passage to producing successful, meaningful and purposeful designs. Furthermore, innovation, by nature, can fail. It is important to guide the students to an understanding that a failed project can still be a valuable learning experience and that the iterative nature of the cycle promotes building upon and adjusting to these blockages through redesign and further testing.

Some of the difficulties that participants experienced with the LDS (and the PPW) could be attributed to the lack of a cohesive, user friendly work environment to guide and scaffold the process. The provision of such an environment has been the goal of the Metis project in developing the Integrated Learning Design Environment (Hernández-Leo et al., 2014).

DOUBLE LOOP DESIGN: COMBINING THE PPW AND LDS METHODOLOGIES

As an instrument for considering the future possibilities for the use of the SNaP! framework, we use the design scenario structure to demonstrate the potential synergy of LDS and PPW as complementary components of a professional development programme. Currently, this scenario is being explored in the context of a Masters level programme in Higher Education at the University of Surrey.

Context

The programme is firmly rooted in academic practice and is being designed, in its’ first iteration, to run with university teachers. It will be delivered in an entirely online format and the modules that address technology enhanced learning provide an opportunity to interrogate educational technology deployment in the authentic contexts that the participants bring with them. These contexts are being increasingly dominated by the challenge that teaching in a networked learning setting presents and the acknowledgement that digital networks have become an essential part of the learning environment (Dirckinck-Holmfield, 2009).

The Challenge of Connecting Theory and Practice

How do we make theory relevant to practitioners, and at the same time help them develop an inquiring scientific attitude towards their work? A well-documented weakness of teacher training programs is the disconnect between theory and practice (Mellar, Oliver, & Hadjithoma-Garstka, 2009; Davies, 1999). Korthagen et al. (2001) show that not only do teachers find themselves ill-equipped to translate the theoretical abstractions to the concrete context in which they work, their negative experience in attempting to do so results in theory aversion: teachers feel threatened by educational theory and see teacher education as detached and undervalued.

Double Loop Design: Combining LDS and PPW Approaches as a Programme Component

Our solution to this challenge is the creation of a programme that includes two complimentary components arranged in a 'figure of eight' loop (Figure 3). The first, structured as a learning design studio, offers students an opportunity to engage in educational innovation, while maintaining a rigorous view and making their own connections with theory. The second, modelled after the Participatory Pattern Workshops, leads them through a process of collaborative reflection and cumulates in the production of publishable quality outputs.

Learning Design Studio Module

We begin with a 15 credit module. Students work in groups on projects as described in the LDS methodology and prototype solutions in their particular domain of inquiry. We begin by introducing the methodology itself, through review papers and example projects. The course ends with an open "crit" (critique session), where students present their projects to a wide audience.

Participatory Pattern Workshop Module

In a second 15 credit module, students use narratives, patterns and scenarios to collaboratively reflect on their practical experiences. They can accomplish this either by reference to the LDS module or to other modules in the programme. First, they share narratives from their projects and critique their peers' narratives, using a given evaluation rubric. They refine their narratives in response to comments, and proceed to elicit patterns from common themes identified across narratives. These patterns are substantiated by reference to relevant literature, and connected to form pattern languages. The students then validate these patterns by using them

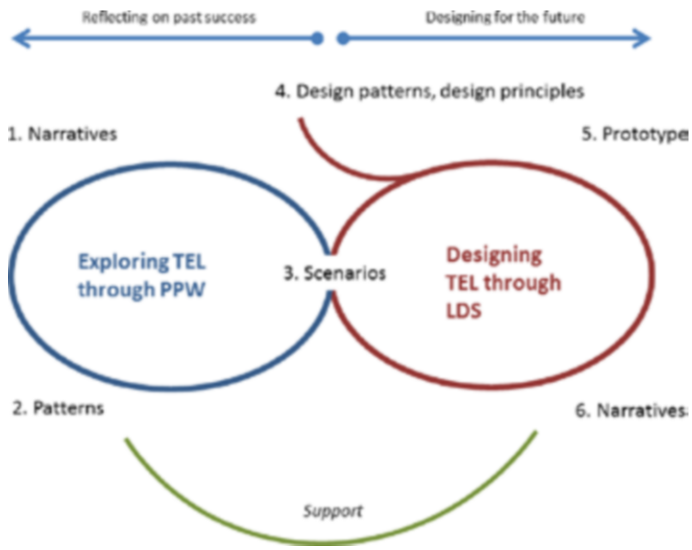

Figure 3. The figure of eight 'double loop design' model describes the relationship between the elements within the PPW and LDS methodologies that form the two complimentary components. 'Exploring TEL' reflects on past success from its' starting point in design narratives that culminates in the production of design patterns. 'Designing TEL' addresses current educational challenge and uses design patterns (and principles) to address the challenges with design scenarios.

to construct solutions for novel scenarios. Finally, working in groups, the students collate narratives, patterns and scenarios to form publishable quality outputs.

CONCLUSIONS

The 'double loop design' model proposed here combines the two learning design approaches documented in this paper and provides a powerful and complementary dual learning process. These learning processes are linked by narratives of design success that are recorded from prior experience and also generated during the evaluation of successful design prototyping activity. It engenders the development and then application of deep and meaningful design knowledge with a reflective conversation that directly interrogates their practical experience. We are confident that this novel approach will produce both deep learning and innovative thinking. The SNaP! Framework in the configuration of 'double loop design' provides both a comprehensive set of representations and a system of practices for articulating, sharing, aggregating, and manipulating design knowledge in education.

REFERENCES

Alexander, C., Ishikawa, S., & Silverstein, M. (1977). *A pattern language: Towns, buildings, constructio*n. New York, NY: Oxford University Press.

Béguin, P. (2003). Design as a mutual learning process between users and designers. *Interacting with Computers*, *15*(5), 709–730.

Bruner, J. (1991). The narrative construction of reality. *Critical Inquiry*, *18*, 1–21.

Cross, N. (2006). *Designerly ways of knowing*. New York, NY: SpringerLink.

Cross, S. (2013). *Evaluation of the OLDS MOOC curriculum design course: Participant perspectives, expectations and experience*s. OLDS MOOC Project, Milton Keynes. Retrieved from http://oro.open.ac.uk/37836/

Davies, P. (1999). What is evidence-based education? *British Journal of Educational Studies*, *47*(2), 108–121.

Dewey, J. (2007). *Experience and education.* New York, NY: Simon and Schuster (Original work published 1938).

Dirckinck-Holmfield, L., Jones, C., & Lindström, B. (Eds.). (2009). *Analysing networked learning practices in higher education and continuing professional development*. Rotterdam, The Netherlands: Sense Publishers.

Dirckinck Holmfeld, L., Hodgson, V., & McConnell, D. (Eds.). (2012). *Exploring the theory, pedagogy and practice of networked learning.* New York, NY: Springer Verlag.

Goodyear, P., Avgeriou, P., Baggetun, R., Bartoluzzi, S., Retalis, S., Ronteltap, F., & Rusman, E. (2004). *Towards a pattern language for networked learning*. Proceedings NLC 2004. Retrieved 10th January 2014 from http://www.networkedlearningconference.org.uk/past/nlc2004/proceedings/individual_papers/goodyear_et_al.htm

Green, L. N., & Bonollo, E. (2003). Studio-based teaching: History and advantages in the teaching of design. *World Transactions on Eng and Tech Edu, 2*, 269–272.

Hernández-Leo, D., Asensio-Pérez, J. I., Derntl, M., Prieto, L. P., & Chacón, J. (2014). *ILDE: Community Environment for Conceptualizing, Authoring and Deploying Learning Activities*. Proceedings of 9th European Conference on Technology Enhanced Learning, EC-TEL 2014, Graz, Austria, September 2014 (p./pp. 490–493).

Kali, Y. (2006). Collaborative knowledge building using a design principles database. *International Journal of Computer-Supported Collaborative Learning*, *1*, 187–201.

Korthagen, F., Kessels, J., Koster, B., Lagerwerf, B., & Wubbels, T. (2001). *Linking practice and theory: The pedagogy of realistic teacher education*. Mahwah, NJ: Lawrence Erlbaum Associates.

Littleton, K., Scanlon, E., & Sharples, M. (Eds.). (2012). *Orchestrating inquiry learning.* London, UK: Routledge.

McAndrew, P. (2013). Learning from open design: Running a learning design MOOC. *eLearning Papers, 33,* 1–4.

Mellar, H., Oliver, M., & Hadjithoma-Garstka, C. (2009). The role of research in institutional transformation. In T. Mayes, P. Bullen, H. Mellar, & M. Oliver, (Eds.), *Transforming higher education through technology-enhanced learning.* York, UK: Higher Education Academy.

Mor, Y. (2013). SNaP! Re-using, sharing and communicating designs and design knowledge using scenarios, narratives and patterns. In R. Luckin, P. Goodyear, B. Grabowski, S. Puntambekar, N. Winters, & J. Underwood (Eds.), *Handbook of design in educational technology* (pp. 189–200). London, UK: Routledge.

Mor, Y., & Mogilevsky, O. (2013a). The learning design studio: Collaborative design inquiry as teachers' professional development. *Research in Learning Technology, 21*.

Mor, Y., & Mogilevsky, O. (2013b). *Learning design studio: Educational practice as design inquiry of learning 'scaling up learning for sustained impact'* (pp. 233–245). Berlin & Heidelberg: Springer.

Mor, Y., Warburton, S., & Winters, N. (2012). Participatory pattern workshops: A methodology for open learning design inquiry. R*esearch in Learning Technology, 20*.

Mor, Y., Craft, B., & Hernández-Leo, D. (2013). Editorial: The art and science of learning design. *Research in Learning Technology, 21.*

Mor, Y., Mellar, H., Pachler, N., & Daly, C. (2010). Formative e-Assessment: Case stories, design patterns and future scenarios. In C. Kohls & J. Wedekind (Eds.), *Problems investigations of e-learning patterns: Context factors solutions* (pp. 199–219)*.* Hershey, PA: Information Science Publishing.
Mor, Y., Mellar, H., Warburton, S., & Winters, N. (2014). *Practical design patterns for teaching and learning with technology*. Rotterdam, The Netherlands: Sense Publishers.
Schön, D. A. (1992a). The theory of inquiry: Dewey's legacy to education. *Curriculum Inquiry*, *22*(2), 119–139.
Schön, D. A. (1992b). Designing as reflective conversation with the materials of a design situation. *Knowledge-Based Systems, 5*(1), 3–14.
Stoyanov, S., Sloep, P., De Bie, M., & Hermans, V. (2014). *Teacher-training, ict, creativity, MOOC, moodle – what pedagogy?* EDULEARN14 Proceedings (pp. 5678–5686), 7–9 July, 2014,: IATED. Retrieved from http://dspace.ou.nl/handle/1820/5463
Warburton, S. (2009). *WP4c report on design patterns for virtual worlds*. Retrieved 10 October 2013 from http://dl.dropbox.com/u/4424450/KCL_v6_MUVENATIONDesignPatternsWP4.pdf
Warburton, S. (2013). Space for lurking: A pattern for designing online social spaces. In S. Warburton & S. Hatzipanagos (Eds.), *Social media and digital identity* (pp. 149–158). Hershey, PA: IGI Global.

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8. TOWARDS A PRINCIPLED APPROACH TO EVALUATING LEARNING DESIGN TOOLS

From Proof of Concept to Evidence of Impact

INTRODUCTION

This chapter turns the spotlight from the design and development of digital tools that support the practice of learning design ('learning design tools') to their evaluation, a phase in the design-development cycle that has arguably received less treatment in the learning design research literature than it merits. The increasing maturity and sophistication of learning design tools mean that it is no longer sufficient merely to demonstrate 'proof of concept': namely, the feasibility, in broad terms, of digital tools that can support teachers in designing their students' learning and their acceptability to their target audience (for example, as investigated by Masterman & Manton, 2011). Rather, we face the requirement to demonstrate their *effectiveness*: i.e., that their use really can make a difference to teachers' design practice – whether as a justification for further research or in order to attract support to turn a research prototype into a working system for teachers to use in their everyday practice.

Methodologically, this requirement calls for more mature and sophisticated approaches to evaluation, including combining an 'inside-out' perspective – capturing teachers' opinions and self-reported behaviour – with an 'outside-in' perspective: developing reliable techniques by which researchers can capture teachers' behaviour, as well as metrics to determine the extent to which their interactions with the tool are successful in producing the desired outcome. A principled, theory-informed approach can help both to guide the design and conduct of the evaluation, and to give cohesion to data collected from disparate individuals.

The chapter explores some of the issues associated with such a theory-informed approach. It draws on the experience of designing the evaluation of the Learning Designer tool (Laurillard et al., 2013), in order to map out the issues in formulating and implementing a theory-informed evaluation framework. It begins with by outlining the successive forms of evaluation in the software development cycle before briefly describing the Learning Designer and the objective of its evaluation: to achieve an impact on teachers' design practice. It then presents the three principles that guided the assembly and early implementation of the framework, and in so

M. Maina et al. (Eds.), The Art & Science of Learning Design, 105–120.

doing identifies a number of issues raised by this process. The chapter concludes by asserting the position of evaluation as integral to the science of learning design.

EVALUATION IN ITERATIVE DEVELOPMENT METHODOLOGIES

Evaluation with representatives of the intended user population is a core component of human-centred software development methodologies (Maguire, 2001). These methodologies are characterised by iterative cycles of design, development and evaluation of successive prototypes of the emergent tool. Once a prototype has been developed that is sufficiently robust to be trialled with users working on authentic tasks, it can be evaluated for a) its usability and learnability, and b) its usefulness to teachers' design practice. Examples of such evaluations reported in the learning design literature include OpenGLM (Derntl, Neumann and Oberhuemer, 2011), Scenedit (Emin and Pernin, this volume), CADMOS (Katsamani, Retalis and Boulakis, 2012), and Web Collage (Villasclaras-Fernández et al., 2013). Only when these issues have been substantially resolved is it possible to evaluate effectiveness: that is, whether users' engagement with the tool results in a sustained change in their practice.

THE LEARNING DESIGNER: A TOOL FOR ACHIEVING IMPACT

The Learning Designer comprises a digital tool and guidance to support university teachers in the design of learning activities, with an emphasis on technology-enhanced learning (TEL). Its development was based, in large part, on the findings from two earlier design-based research projects: the London Pedagogy Planner (San Diego et al., 2008) and Phoebe (Masterman & Manton, 2011). The Learning Designer is more advanced than its predecessors, with support for multiple levels of design (activity, session and module) and the incorporation of artificial intelligence.

Overview of the Learning Designer

The Learning Designer scaffolds the design process with advice on decisions that include aims, learning outcomes, assessment method, the learning activities that students will carry out and the different technologies that can support these activities. As shown in Figure 1, teachers assemble learning activities into a sequence by dragging each one from a palette of generic descriptions onto a timeline, and then specifying information such as name, duration and the number of students involved in small-group collaborative work.

A key research objective of the Learning Designer project was to investigate how artificial intelligence (specifically, knowledge engineering) can provide adaptive support as teachers work through the design process, by making inferences from comparisons between the user's decisions and a knowledge base of design practice.

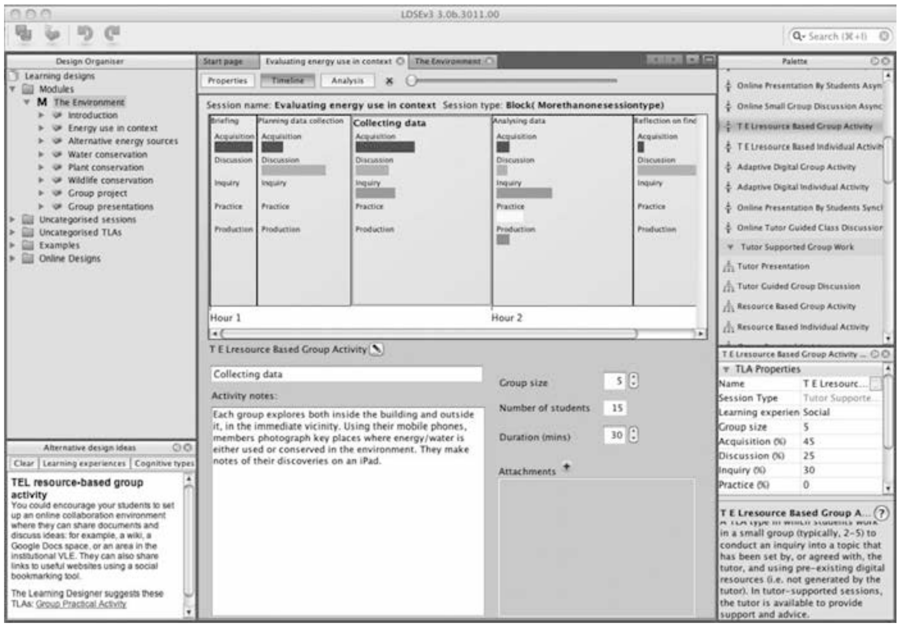


Figure 1. The Learning Designer's timeline

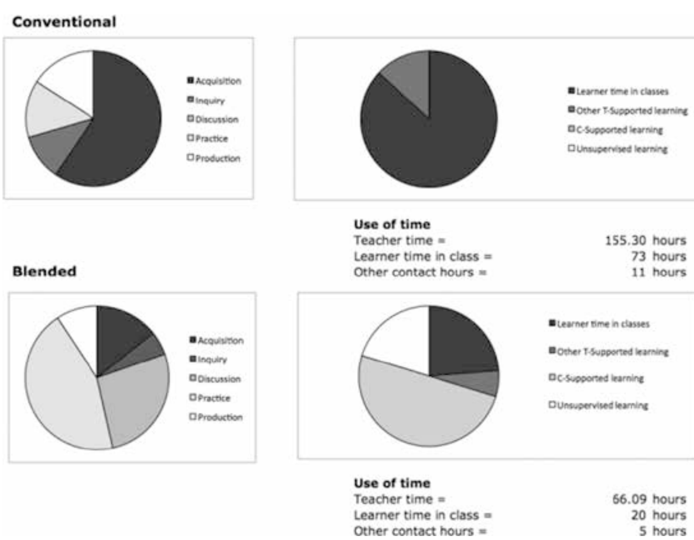


Figure 2. Modelling two different versions of the same course ('conventional' and blended)

For example, at the bottom left corner of Figure 1 the Learning Designer has drawn from the knowledge base to suggest how the user could enhance the chosen activity.

The Learning Designer can also model variations of the same learning design, or two different designs, in order to give teachers novel insights into their pedagogy. For example, it can analyse the learning experience that a learning design is likely to support in terms of five *cognitive activities*: acquisition, inquiry, discussion, practice and production. It can then draw from the knowledge base to suggest ways of varying this learning experience. Teachers can also model the effect of moving from a face-to-face to a blended model, as shown in Figure 2, where the move has altered the proportions of cognitive activities and the distribution of the teacher's and learners' time.

Additionally, a library of exemplar learning designs for inspiration or adaptation provides opportunities for teachers to build on the work of others, and multimedia case studies enable learning through observing practice beyond one's home institution.

Objective and guiding principles of the evaluation

In relation to teachers' engagement with the tool, the Learning Designer project set itself another challenging research objective: to achieve an impact on their practice in designing technology-enhanced learning. Therefore, rather than merely exploring its value from the perspective of teachers, the evaluation team was charged with the task of determining and assessing whether – and how – use of the Learning Designer could be a factor in effecting lasting, beneficial changes in teachers' design practice.

Work on the theoretical underpinning of the evaluation proceeded in two overlapping areas: i) elaborating our understanding of 'impact', drawing on previous research literature and formulating a framework for scoping and measuring it (reported here), and ii) making sense of the individual teacher's experience of that impact within their own socio-cultural context (reported in Masterman and Wild, 2011).

The work was guided by three interrelated principles:

1. When investigating the impact of a new tool on teachers' practice, researchers should study not only what teachers do, but also how they think about (conceptualise) their teaching.
2. Teachers' learning design practice comprises at least some cognitive actions and behaviours that can be directly observed or elicited in a reliable manner, and are amenable to change under the influence of new tools or other mediational means.
3. When investigating the introduction of a new tool into teachers' practice, researchers should adopt a methodology that looks for *qualitative* differences in that practice as much as (if not more than) quantifiable changes.

The next three sections of the chapter explicate these principles in more detail.

IMPACT AND RELATED CONCEPTS: SCOPING THE PROBLEM SPACE

An everyday definition of impact is: 'a strong influence,' where 'influence' can be defined as 'the capacity to have an effect on the character, development, or behaviour of someone or something' (Oxford Dictionaries Online, 2012). Biggs (2003) implies that to bring about 'enduring change' in their approach, the teacher needs both to act and to think differently about teaching. However, the verb 'think' conceals an array of constructs that encompasses beliefs, attitudes, intentions and a host of other 'affective variables' (Koballa, 1988, p. 115) within an individual which influence his or her behaviours (i.e. actions).

Drawing on the work of, *inter alia*, Fishbein and Ajzen, Koballa (1988) suggests that a belief is a cognitive link that associates some attribute to an object: for example 'digital technologies have the capacity to benefit students' learning.' Beliefs may range from descriptive to evaluative, and may be of varying strengths. An attitude is 'a learned predisposition to respond in a consistently favourable or unfavourable manner toward an attitude object' (Fishbein & Ajzen, 1975, cited in Koballa, 1988, p. 116): for example, 'I like using digital technologies to support my students' learning.' Attitudes are influenced by beliefs and, insofar as they are 'predisposition[s] to respond' (Koballa, 1988), have a bearing on the intentions that, in turn, influence specific actions that the individual performs: for example, 'I intend to use audience response systems with my students.' The choice of the verb 'influence' is deliberate, as holding a particular belief (or attitude) does not necessarily mean that an individual will adopt a particular attitude (or intention), and a statement of intention may not actually result in the action itself. Conversely, an observed change in behaviour is not necessarily indicative of a change in an underlying attitude or, even, a belief. For example, a university lecturer who dislikes using TEL but starts uploading her lecture notes to the virtual learning environment every week for her students' benefit may not have undergone a change in attitude: rather, she may just be following a new institutional directive.

In considering the role of beliefs in relation to changes in teachers' engagement with TEL, Ertmer (2005) observes that two sets of beliefs are in play: i) the teacher's general pedagogic beliefs and ii) the teacher's beliefs about what digital technologies can bring to teaching and learning. She suggests that the second set is less important to teachers and, hence, more easily changed. Moreover, in terms of changes to teachers' behaviour, Ertmer distinguishes between *first-order* changes – incremental, and reversible, adjustments in current practice that have no effect on an individual's existing beliefs – and *second-order* changes that confront deeply-held beliefs and, in so doing, entail 'new ways of both seeing and doing things' (2005, p. 26) that are irreversible. This reflects Guskey's (2002) model of teacher change, which suggests that teachers' attitudes and beliefs are likely to change only *after* they have gained evidence of improvements in students' learning through modifying their practice.

Thus, if we assume (as Ertmer appears to) that changing pedagogic beliefs entails a shift from a teacher-centred (knowledge-transmission) approach to a student-centred (social constructivist) approach, this would allow for a teacher to innovate in relation to their current practice, but without any fundamental change to the way in which they engage with their students, or the students with each other. That is, they are merely 'replicating their current practice in a digital environment, rather than exploring ways in which they can use that environment for genuine innovation' (Laurillard & Masterman, 2010, p. 233). Significantly for our purposes, Ertmer reports research suggesting that schoolteachers may take up to six years to develop social constructivist approaches to their use of TEL – and the same may well hold true for university teachers. Observing individuals over such an extended period is beyond the remit of most research projects, including our own.

So far, we have concentrated on impact on the individual teacher, rather than considering the socio-cultural context in which he or she is working. This context is important for two reasons. First, contact with others can be a powerful instrument for effecting impact on the individual teacher, whether through vicarious learning (such as peer observation), or participation in 'professional communities that discuss new materials, methods, and strategies, and that support the risk taking and struggle involved in transforming practice' (Ertmer 2005, p. 34). Second, if changes in practice are to spread beyond isolated pockets of innovation, then the penetration of impact to course teams, departments/faculties, institutions and, ultimately, the entire higher education sector must also be considered (extrapolating from Kaufman, Keller and Watkins, 1995). This renders the landscape of impact more complex, since not only must we additionally take account of collective beliefs, attitudes and behaviours and their relationship to their counterparts within the individual group members, but we must also consider the institutional mechanisms for initiating, disseminating and sustaining the interventions that are intended to effect the desired impact. For this reason, we confined our evaluation of the Learning Designer to its impact on individuals.

EVIDENCE: IDENTIFYING 'DESIRABLE' TEL DESIGN PRACTICE

Applying the second of the three principles entails identifying the aspects of learning design practice in which we would look for changes that might constitute evidence of impact of engaging with a tool such as the Learning Designer. For present purposes, 'desirable' denotes practice that is the outcome of change which is a) relative to one's practice prior to some kind of intervention (whether technology-supported or not), and b) in the direction intended by the instigator of that intervention. Of necessity, the focus is on behaviours, although attitudes and beliefs can be taken into account where they can be averred with reasonable confidence or triangulated in the research literature.

To elicit a set of 'desirable' behaviours, we reviewed the characteristics of TEL design practice that we had encountered in our own previous research (Masterman and Manton, 2011; San Diego et al., 2008;) or are acknowledged in the higher education research literature. The principal characteristics that we identified related to the following:

- concern for the student experience (Ertl et al., 2008);
- the theoretical influences on lecturers' teaching approaches (Mayes & de Freitas, 2007);
- the extent to which they consult pedagogic research (Vanderlinde & van Braak, 2010);
- the role and nature of reflection (Lawes, 2004);
- the sharing and reuse of learning materials (Littlejohn, Falconer, & McGill, 2008);
- participation in communities of like-minded practitioners (Triggs & John, 2004).

These characteristics underpinned the design of semi-structured interviews with university professionals about their current practice, which the author conducted during the requirements elicitation phase of the Learning Designer project. Ten individuals participated. All had at least five years' teaching experience, were well versed in digital technologies and represented a range of roles: lecturers in a range of disciplines (sciences, social sciences and humanities), educational developers and learning technologists. In principle at least, we would expect them to be highly aware of their own behaviours and also well placed to articulate the behaviours and conceptions (or misconceptions) of early-career lecturers, as well as those of seasoned academics who have yet to engage with TEL. We did not specifically ask interviewees about the evolution of their practice or about the people, events, or artefacts that had effected a significant impact on them, but in many cases interviewees spoke about these spontaneously.

The interviews were audio-recorded and transcribed. They were analysed initially by the author, and the resulting list of five behaviours was reviewed for reliability by a second researcher. These behaviours are:

- innovating in relation to one's current practice;
- giving due weight to students' needs;
- espousing theories of learning and teaching;
- building personal professional knowledge;
- participating in a knowledge-building community.

This list is neither exhaustive nor definitive: throughout our research we remained open to the possibility that additional dimensions of practice might be uncovered, or that the existing dimensions might require modification.

Innovating in Relation to One's Current Practice

In terms of TEL design, innovation means going beyond simply moving one's current practice online to considering the possibilities for different forms of teacher-student and student-student interaction. For example, a lecturer in Business Studies summarised the evolution in her behaviour in terms that are strongly redolent of Ertmer's observation regarding the shift in pedagogic beliefs from a teacher-centred to a student-centred model:

> I've moved away quite a lot from just delivering subject content to trying to get students to think much more about… having different kinds of conversation with each other about whatever it happens to be that we're teaching, so they can learn from each other.

This innovation can have an affective impact on the experience of learning in addition to improved performance. For example, the same lecturer contrasted her institution's pedestrian requirement for each course to have a site on the VLE containing the student handbook and lecturers' contact details ('where's the joy in that?') with the creative use of a wiki to write an essay, gather formative comments and facilitate vicarious learning:

> One of our Master's students […] did an evolving essay and several of us all commented as she was going, and it was published and it was in a wiki page, and we all kind of contributed and put things in and she reflected on it, and we had that running live. And several different Master's groups were […] looking at the kinds of comments. […] it's kind of getting the joy of the sharing.

Giving Due Weight to Students' Needs

The centrality of students' needs and preferences was apparent in a number of interviews. For example, a lecturer in Educational Development noted that a university teacher should understand

> where students are and where students might be, […] what tools are appropriate and how to develop certain skills in the classroom or outside the classroom in terms of understanding [the] sort of flexibility that students might need or develop.

In practical terms, interviewees used TEL to address particular needs, such as putting lecture notes online for the benefit of students who arrived late at early-morning lectures on account of childcare responsibilities, or setting mathematics problems in Facebook as extension exercises to motivate more able students and enable them to be mentored by peers in the year above.

Espousing Theories of Learning and Teaching

Theories, frameworks, models and taxonomies of learning and teaching are now widely considered to play a key role in the effective integration of digital technologies into teaching and learning (Mayes and de Freitas, 2007). Interviewees mentioned using a wide range of theories: principally social constructivism, Biggs' constructive alignment, Kolb's learning cycle, and Bloom's taxonomy. Behaviourism was the least cited theory.

Purposes for which interviewees used theory included:

- to inform the process of design: 'to better understand what it is you're doing, or probably to validate what you're doing or to extend what you are doing' (lecturer in Educational Development);
- as a scaffold for reflecting on one's own practice, especially if a class did not go according to plan: 'You reflect back against the model: did it fit? "Did this model describe what I saw happening and if so why was that?"' (educational developer);
- to lend weight to arguments about pedagogy: for example, to help make the case for students to produce a reflective portfolio instead of writing a summative essay 'because it's the only reasonable way to examine their research skills gained over this module' (Humanities lecturer).

Building Personal Professional Knowledge

This behaviour can take two forms: building on the work of others and consulting the findings of pedagogic research.

Building on the work of others entails seeking to improve one's own practice by drawing inspiration from, or even adapting, examples and ideas that may come from colleagues, from outside one's home institution, or even, outside one's home discipline. A striking example of cross-disciplinary borrowing came from the Humanities lecturer:

> I got taken along [to a workshop] to see what reusable learning objects were, and I got this lovely example of fulcrum, load and effort, and a car crashing into a wall […] And I thought, 'Well that's not what I do because I don't teach a concept that can be grasped like that.' And […] I had an epiphany because I suddenly went, 'Oh, so when I'm teaching, that means I could do this!'

Consulting the findings of research into learning and teaching was conspicuously absent from general practice. One educational developer commented in respect of colleagues that 'Higher education as a discipline I don't think is recognised by people who haven't thought of it already as being a discipline.' However, the Humanities lecturer, who had an additional role as an advisor in a cross-institutional body for her discipline, commented on the value of research findings in 'tooling people up' with evidence to support a particular pedagogic approach.

Participating in a Knowledge-Building Community

Participation in a community entails acknowledging that one's own practice can be a source of inspiration to others, and being willing both to share one's work for peer review and to peer-review other teachers' work. As with building on the work of others, it may involve crossing institutional and disciplinary boundaries.

The lecturer in Educational Development was strongly aware that teachers do not (even cannot) design in isolation: 'there's sort of an increasing need as well in terms of developing a design to do it as a community practice, to share and critique ideas and to get the students' feedback on those.' He had recently run a project that built a cross-institutional learning design community whose members met every few months, and he attributed its success in part to a shared interest: 'we were excited about […] how other people were thinking about learning.'

In contrast, a learning technologist in a Humanities faculty, who was developing communities of lecturers wishing to build their skills in Web 2.0 tools, felt it was important that members should come from similar disciplines: 'You need to have the shared domain so that you're kind of talking about the same things and doing the same things, and that helps you form a more natural community of practice.' However, for the lecturer in Business Studies, the essential criterion is the existence of like-minded individuals. Lacking these among her departmental colleagues, she had gravitated towards a cross-disciplinary informal network fostered by the co-ordinator of her university's teaching and learning centre.

Behaviours and Beliefs

Reviewing these five behaviours, it might be easy to observe that, at bottom, they could just as easily be influenced by pedagogic beliefs alone and that beliefs about the relationship of technology to learning (hence, using TEL) are not really necessary. However, the two sets of beliefs can interact i) when teachers perceive that technology can add to their students' learning or address particular requirements that stem from their pedagogic beliefs, and ii) when technology-related beliefs necessitate a deeper engagement with pedagogic beliefs as well (for example, turning to theory to inform one's TEL practice). However, even when promoting TEL, one must remain mindful of the primacy, in teachers' minds, of pedagogic beliefs.

METHODOLOGY: APPLYING QUALITATIVE MEASURES OF IMPACT

The theoretical underpinning of our third principle lies in the writings of the socio-cultural theorist Wertsch, according to whom, 'with the introduction of a new […] tool into the flow of human action we should be on the lookout for qualitative transformation of that action rather than a mere increment in efficiency or some other quantitative change' (2002, p. 105).

In relation to learning design, an increase in efficiency would equate to taking less time to develop a design that results in students' achievement of the same, or improved, performance. However, this measure falls short for two reasons. Firstly, it is not reliable. Although one may fashion a learning design so as to maximise the likelihood that learning outcomes will improve, the ultimate effectiveness of the design is contingent upon factors that are not wholly predictable: namely, the students and the learning setting (Beetham & Sharpe, 2007). Secondly, as we have seen, time is a key factor in effecting a durable change in behaviour and the affective variables that underlie it, meaning that researchers with limited resources may only capture first-order changes in behaviour or emergent shifts in attitude. Neither of these is sufficient to indicate the sustainability of change; moreover, one must additionally guard against simplistic predictions based on teachers' statements of intention. Researchers therefore need ways to determine the extent of impact at a given point, or to be able to interpret in a realistic manner, data that can only collected over a shorter period.

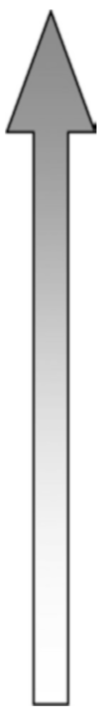
A framework that addresses the second shortcoming is the Higher Education Academy's six-level Academy Evaluation and Impact Assessment Approach (HEA, 2009), which offers us a means to measure impact along a trajectory. The framework was originally developed to enable HEA staff to assess the impact of their activities with institutions and subject communities intended to enhance students' learning experience. Impact is measured on six levels: 1 – Awareness of the activity, 2 – Reactions: an informed choice to find out more, 3 – Engagement with the activity, 4 – Learning from the activity, 5 – Applying one's learning, and 6 – Effects on student learning. Levels 2, 3–4, 5 and 6 bear some resemblance to the four-level evaluation framework formulated by Kirkpatrick (1967, cited in Kaufman, Keller & Watkins, 1995).

The HEA's framework was adopted in the Learning Designer project for two reasons. Firstly, it offers a means to measure the impact of teachers' engagement with the tool on a qualitative scale. Secondly, it provides a set of descriptors which recognise that teachers, rather than students, are the immediate beneficiaries of the activity being assessed. Table 1 shows a tentative interpretation of the framework to the Learning Designer. At levels 1 to 3, the teacher's engagement with the tool is brokered by the project team (for example, through workshops), while from level 4 onwards the teacher begins to work more independently, applying what they have learned to their everyday practice. Note that 'learning better' (level 6) is deliberately not specified: teachers are free to define this for themselves in terms of process, outcomes or both.

Although the descriptions are phrased in positive language, they do not assume that the user unreservedly endorses the Learning Designer: indeed, one would expect users to make constructive critiques as well. It is also important to note that, at any level, a teacher may feel that the tool is no longer making any difference to his or her practice. Such cases may help the researcher to draw inferences regarding the kinds of teacher – in terms of personal disposition as well as professional experience – who are most (conversely, least) likely to benefit from engaging with the Learning Designer.

With experience of applying the framework, it should become possible to map the evolution of individuals' attitudes, intentions and beliefs as they move through the six levels. For example, some may approach the Learning Designer with beliefs about pedagogy and TEL that are already conducive to productive engagement with it, while others may be more sceptical and may only modify their beliefs when they have seen sustained examples of improved student performance (cf. Guskey, 2002).

Table 1. Applying the HEA Academy Evaluation and Impact Assessment Approach to teachers' engagement with the Learning Designer



Level:	*Manifestations of impact at this level and indications of progression to the next:*
6. Effects on students' learning	Identify sustained instances of students learning better as a result of one's enhanced practice; confidently explore the potential for innovating further in one's teaching.
5. Applying one's own learning	Use the Learning Designer to redesign one's teaching to take account of these new ideas/insights. Begin to identify the effects, both on students' learning and on one's own approach.
4. Learning from	Through working with the Learning Designer, further formulate and develop ideas about one's practice, reflecting on the possible ways in which it might be improved.
3. Engagement	Use the Learning Designer to (re)develop a learning design from one's own curriculum. In so doing, identify new ideas, approaches and perspectives that could be applicable to one's practice.
2. Reactions	Feel positive about the potential for enhancing teaching and learning through the Learning Designer; seek and take up opportunities to try it out.
1. Awareness	Read/hear of the existence of the Learning Designer and recognise the potential for enhancing both students' learning and one's own practice through its use.

SYNTHESIS AND IMPLICATIONS FOR EVALUATING THE LEARNING DESIGNER

In this section, the outcomes from the preceding explication of our three guiding principles are synthesised into a plan for evaluating the Learning Designer tool. We start by summarising the contribution from each principle.

1. *Studying what teachers do and think.* The exploration of 'impact' and its associated concepts draws attention to the within-individual variables at play and, in particular, reminds us that impact is not immediate and can be reversible. It is not enough, therefore, to make claims on the basis of superficial behaviours or

self-reported intentions, particularly where the period of study is short. Equally, an appreciation of these variables can help to explain why impact might be achieved more quickly in some individuals than others: for example, where a teacher already has a positive disposition towards TEL and a belief in the value of continuous personal professional development.

2. *Observable practice.* The five TEL design behaviours provide a set of categories of evidence that enable us to answer the question 'What is changing in teachers' practice?' as they engage with the Learning Designer and apply their enhanced professional knowledge to the design of students' learning.
3. *Qualitative methods of evaluation.* The framework for analysing the progression of impact offered by the HEA's Evaluation and Impact Assessment approach enables us to make realistic claims of impact where the period of study is restricted. Moreover, building up a profile of the levels reached by a substantial number of users may allow a simple quantitative analysis where stakeholders require data that carry the 'weight of numbers'.

The researchers' brief – to assess the impact of working with the Learning Designer – invited an evaluation design that would follow a traditional 'pre-test→exposure→post-test' format over an extended period, but would adopt primarily qualitative methods: descriptive evidence from observations, and reactions and feedback collected directly from participants in think-aloud procedures, interviews, focus groups and/or questionnaires. Case studies could also be considered, but as illustrations, not measures, of impact (Grant et al., 2009).

Shortcomings are, of course, inherent in these techniques. Researchers cannot rely on self-reporting by participants as reliable evidence of what they do, think or believe; neither should researchers automatically draw causal inferences merely from observing participants' behaviour. It is advisable to triangulate data from these sources: for example, through embedding the evaluation in educational development programmes, where the course leader can comment on participants' data in light of his/her knowledge of their broader professional evolution.

In the Learning Designer project, the emergent state of the software, coupled with the difficulty of engaging with lecturers at a time when they were actively designing (or redesigning) their courses, restricted the scope and ambitions of the evaluation to one-day workshops with 8–16 lecturers and walkthroughs with individual lecturers. Hence, we confined our expectations (and with them, our claims) to first-order changes in behaviour commensurate with levels 1–3 of the HEA framework, and to possible shifts in attitudes and intentions in relation to the five TEL design behaviours. However, these limitations did not entirely diminish our endeavours. We were able to test our assumptions regarding the five behaviours, such as the espousal of theory, which the data suggested might be stronger in early-career lecturers than experienced ones.

As a consequence of the qualitative focus of the evaluation and the limited time available to us, we found ourselves moving away from measuring impact as outcome to capturing and describing impact in the process of happening, and looking to the data to give us an indication of the conditions that might be conducive to the achievement of the desired impact. Thus, the evaluation question began to shift from 'Have we achieved an impact, through the Learning Designer, on teachers' practice in designing TEL?' to 'What does it take to achieve an impact on practice, in terms of the individual, the Learning Designer and the socio-cultural context?'. This would entail evaluating the Learning Designer not in isolation, but as part of an ecology of supportive tools and resources, which could also include fellow teachers.

A further consideration to make, both in formulating the evaluation question and in analysing the data, is the extent to which change can be attributed to the Learning Designer itself: that is, whether a teacher's changed practice has resulted from 'learning' from the Learning Designer, or from the opportunity to reflect on their practice and discuss it with others that has afforded by their engagement with the tool and their experience of its 'disruptive' effect. From an educational developer's perspective the distinction may be immaterial since, as one evaluation participant commented, 'all that matters is that we get people engaging in some kind of reflective process or structural theoretical framework for their teaching.' From a researcher's perspective, however, the difference is substantial.

CONCLUSION

This chapter has foregrounded the importance of a theoretically-informed approach to evaluating the effectiveness of learning design tools, now that 'proof of concept' has been adequately demonstrated. Using the example of work to evaluate the impact on teachers' practice of engaging with the Learning Designer tool, it has outlined an approach to formulating and implementing an evaluation framework based on three interacting principles which had a common springboard in the project objective that drove the evaluation. These were considered to help the researchers define the boundaries of their expectations in terms of the data that could be collected and, hence, guard against making facile generalisations or exaggerated claims on the basis of the data. The chapter has also indicated the existence of a number of methodological and logistical stumbling blocks to the satisfactory implementation of the framework. These suggest that an evaluation of impact on practice may entail a shift of focus from the measurement of outcomes to the analysis of process within a socio-cultural setting.

We do not seek explicitly to offer the principles adopted in the Learning Designer project as exemplars for other projects to follow. Rather, the intention has been to make the case for each project to formulate an approach to evaluating the effectiveness of learning design tools that is based on firm principles, which are themselves supported by relevant theories and the research literature. Such a principled approach to evaluation is, we believe, as integral to the science of learning design as the design and development of the tools themselves. Although evaluation is entwined with development, it must also take an independent stance in order to appraise the effectiveness of the tool in a reliable and valid manner. Rooting the evaluation in a core set of principles maximises the likelihood that this objective will be achieved.

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REFERENCES

Beetham, H., & Sharpe, R. (2007). Introduction. In H. Beetham & R. Sharpe (Eds.), *Rethinking pedagogy for a digital age: Designing and delivering e-learning* (pp. 1–10). London, UK: Routledge.

Biggs, J. (2003). *Teaching for quality learning at university: What the student does* (2nd edition). Maidenhead, UK: The Society for Research into Higher Education & Open University Press.

Derntl, M., Neumann, S., & Oberhuemer, P. (2011). Opportunities and challenges of formal instructional modeling for web-based learning. Proceedings of International Conference on Web-based Learning, December 8–10, 2011, Hong Kong. *Lecture Notes in Computer Science*, *7048*, 253–262.

Ertl, H., Hayward, G., Wright, S., Edwards, A., Lunt, I., Mills, D., & Yu, K. (2008). *The student learning experience in higher education: Literature review report for the Higher Education Academy*. York, UK: Higher Education Academy.

Ertmer, P. A. (2005). Teacher pedagogical beliefs: The final frontier in our quest for technology integration? *Educational Technology Research and Development*, *53*(4), 25–39. doi: 10.1007/BF02504683

Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention, behaviour: An introduction to theory and research.* Reading, MA: Addison-Wesley.

Grant, J., Brutscher, P., Kirk, S., Butler, L., & Wooding, S. (2009). *Capturing research impacts: A review of international practice*. Cambridge: RAND Europe.

Guskey, T. R. (2002). Professional development and teacher change. *Teachers and Teaching: Theory and Practice*, *8*(3/4), 381–391. doi:10.1080/135406002100000512

Hardy, J., & Jefferies, A. (2010). How learners change: Critical moments, changing minds. In R. Sharpe, H. Beetham, & S. de Freitas (Eds.), *Rethinking learning for a digital age: How learners are shaping their own experiences* (pp. 115–128). London, UK: Routledge.

HEA (2009). *Academy evaluation and impact assessment approach*. York, UK: The Higher Education Academy.

Katsamani, M., Retalis, S., & Boloudakis, M. (2012). Designing a moodle course with the CADMOS learning design tool. *Educational Media International*, *49*(4), 317–331. doi:10.1080/09523987.2012.745771

Kaufman, R., Keller, J., & Watkins, R. (1996). What works and what doesn't: Evaluation beyond kirkpatrick. *Performance and Instruction*, *35*(2), 8–12.

Koballa, T. R. (1988). Attitude and related concepts in science education. *Science Education*, *72*, 115–26. doi:10.1002/sce.3730720202

Laurillard, D., & Masterman, E. (2010). TPD as online collaborative learning for innovation in teaching. In J. O. Lindberg & A. D. Olofsson (Eds.), *Online learning communities and teacher professional development; Methods for improved education delivery* (pp. 230–246). Hershey, PA: Information Science Reference.

Laurillard, D., Charlton, P., Craft, B., Dimakopoulos, D., Ljubojevic, D., Magoulas, G., … Whittlestone, K. (2013). A constructionist learning environment for teachers to model learning designs. *Journal of Computer-Assisted Learning*, *29*, 15–30. doi:10.1111/j.1365-2729.2011.00458.x

Lawes, S. (2004). Practice makes imperfect. In D. Hayes (Ed.), *The Routledge Falmer guide to key debates in education* (pp. 197–201). London, UK: RoutledgeFalmer.
Littlejohn, A., Falconer, I., & McGill, L. (2008). Characterising effective e-learning resources. *Computers & Education*, *50*, 757–771. doi:2093/10.1016/j.compedu.2006.08.004.
Maguire, M. (2001). Methods to support human-centred design. *International Journal of Human-Computer Studies*, *55*, 587–634. doi:10.1006/ijhc.2001.0503
Masterman, E., & Manton, M. (2011). Teachers' perspectives on digital tools for pedagogic planning and design. *Technology, Pedagogy and Education*, *20*(2), 227–246. doi:10.1080/1475939X.2011.588414
Masterman, E., & Wild, J. (2011, September). Exploring the concept of mediated action as a framework for analysing learners' and teachers' engagement with digital technologies. Paper presented at the Annual Conference of the Brititsh Educational Research Association, Institute of Education, University of London, 6–8.
Matthews (Masterman), E. (2011). *Evaluating the impact of a digital tool to support teachers' practice in designing technology-enhanced learning: What evidence should we seek and how should we assess it?* Proceedings of the Canada International Conference on Education (pp. 173–8), Toronto, 4–6 April 2011.
Mayes, T., & de Freitas, S. (2007). Learning and e-learning: The role of theory. In H. Beetham & R. Sharpe (Eds.), *Rethinking pedagogy for a digital age: Designing and delivering e-learning*, (pp. 15–25). London, UK: Routledge.
Oxford Dictionaries [Online] (2012). Retrieved from http://oxforddictionaries.com/ definition/english/influence?q=influence
San Diego, J., Laurillard, D., Boyle, T., Bradley, C., Ljubojevic, D., Pearce, D., & Neumann, T. (2008). Towards a user-oriented analytical approach to learning design. *ALT-J: Research in Learning Technology*, *16*(1), 15–29. 10.1080/09687760701850174
Sharpe, R., & Oliver, M. (2007). Designing courses for e-learning. In H. Beetham & R. Sharpe (Eds.), *Rethinking pedagogy for a digital age: Designing and delivering e-learning* (pp. 41–51). London, UK: Routledge.
Triggs, P., & John, P. (2004). From transaction to transformation: Information and communication technology, professional development and the formation of communities of practice. *Journal of Computer Assisted Learning*, *20*(6), 426–439. doi:10.1111/j.1365-2729.2004.00101.x
Vanderlinde, R., & van Braak, J. (2010). The gap between educational research and practice: Views of teachers, school leaders, intermediaries and researchers. *British Educational Research Journal*, *36*(2), 299–316. doi:10.1080/01411920902919257
Villasclaras-Fernández E., Hernández-Leo, D., Asensio-Pérez, J. I., & Dimitriadis, Y. (2013). Web Collage: An implementation of support for assessment design in CSCL macro-scripts. *Computers & Education*, *67*, 79–97. doi:2093/10.1016/j.compedu.2013.03.002
Wertsch, J. V. (2002). Computer Mediation, PBL, and Dialogicality. *Distance Education*, *23*(1), 105–108. doi:10.1080/01587910220124008

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9. WHY HAS IMS LEARNING DESIGN NOT LED TO THE ADVANCES WHICH WERE HOPED FOR?

INTRODUCTION

It seems undeniable that the choice of activities to be carried out by learners has some positive or negative effect on their learning. It also seems reasonable to assume that they can be characterised and grouped into structures which can be usefully exchanged between teachers as a basis for planning activities. These structures are known as learning designs (typically in Europe) or instructional designs (typically in North America) and the groupings are often referred to as patterns (following the approach established by Alexander, Ishikawa and Silverstein (1977)).

Over a number of years work has been done to bring rigour to the choice of learning designs and their evaluation. Reigeluth refers to 'design theories' which "describe methods of instruction and the situations in which those methods should be used, the methods can be broken into simpler component methods, and the methods are probabilistic." (Reigeluth, 1999). This was developed further by Koper, who used the term 'learning design rule' rather than 'instructional design theory': "…learning design knowledge consists of a set of prescriptive rules with the following basic structure: if learning situation S, then use learning method M, with probability P." (Koper & Tattersall, 2005). In his analysis Koper both summarized existing work and inspired a renewal of effort in the field by providing a language which could be applied in creating formal representations of learning designs, and so make it possible to evaluate learning designs more effectively, and to propose explicit and reproducible learning design rules. This language was Educational Modelling Language (EML) (Jochems et al., 2004) later adapted to create IMS Learning Design (IMS-LD) (IMS Global Learning Consortium Inc, 2003a).

It was also hoped that IMS-LD would provide a basis for more flexible systems for the orchestration of learning activities. The specification states that "the objective of the Learning Design Specification is to provide a containment framework of elements that can describe any design of a teaching-learning process in a formal way" and that it was intended to "support mixed mode (blended learning) as well as pure online learning" (IMS Global Learning Consortium Inc, 2003).

These objectives led some educationalists to believe that IMS-LD could be a useful tool in overcoming the constraints that educational technology was seen

M. Maina et al. (Eds.), The Art & Science of Learning Design, 121–136.

to place on teachers, especially those who took a constructivist position (see for example (Dalziel, 2003) and (Buzza, Bean, & Harrigan, 2004). From this perspective the specification was seen as a way of formalising the description of learning designs and patterns, and also of extending the range of possible learning designs which could be implemented with technological support. Consequently, when the IMS-LD specification was published in 2003, it created substantial optimism about its potential for moving forward our understanding of individual learning activities and patterns of activities. Griffiths and Liber (2008) reviewed the 'Opportunities, Achievements, and Prospects for Use of IMS-LD' and concluded that while it had been used as a modelling language by a substantial number of research projects, it had not been adopted extensively by the education community at large, and that the exchange of elearning materials in contexts other than research projects and trials of applications was extremely low.

By 2012 it was clear that although there had been extensive work with the specification, on the whole the aforementioned hopes for IMS-LD had not been fulfilled, and it seems unlikely that widespread adoption of IMS-LD, at least in its current form, will be achieved. If we seek to make progress with the research agenda related to learning designs and patterns, it seems essential to answer the question "Why has the major investment in IMS-LD by educational researchers, teachers, developers and funding agencies not led to the advances which were hoped for?" The work reported in this chapter seeks to shed light on why this has been the case, by capturing and analysing the experiences and explanations of some of those who have worked most closely with the LD specification in a variety of roles.

METHODOLOGY

In responding to our question, it is tempting to conclude simply that the enthusiasts were fundamentally mistaken, and that IMS-LD was not a good specification. Despite the lack of adoption, there is substantial ongoing work to evaluate the goodness or otherwise of specific aspects of the specification (Derntl, Neumann, Tattersall, & Verpoorten, 2009; Derntl, Neumann-Heyer, Griffiths, & Oberhuemer, 2012), and to identify shortcomings which might be remedied (Durand, Belliveau, & Craig, 2010; Konig & Paramythis, 2010; Monfort, Khemaja, & Hammoudi, 2010). While much of this work is valuable, and can provide useful data, conflicting views of the goodness of the specification do not in themselves enable us to draw conclusions which can help us cumulate our research conclusions and plan future work.

Our approach is broadly influenced by the Realistic Evaluation methodology of Pawson and Tilley (1997). They argue that it is counterproductive to classify social science interventions as 'good' or 'bad' in themselves. Rather it is necessary to understand the mechanisms whereby an intervention functions within a context, leading to the observed results. The contexts within which IMS-LD has been deployed are very complex, and the data we have gathered is from diverse perspectives. We do not, therefore, aspire to carry out a comprehensive realistic evaluation as described by Pawson and Tilley. Rather we seek to identify candidate explanatory mechanisms, by interviewing people who have been involved in the IMS-LD specification, have developed applications, or who have used the specification in research or teaching. The interviews sought to elicit the interviewees' theories about the failure of the intervention made by IMS-LD in their area of professional activity. These theories are then formulated as explanatory mechanisms.

Thus the goal of this study is not to reach a definitive judgment about the strengths and weaknesses of IMS-LD, but rather to collect and contrast informed hypotheses from key researchers which can be tested in further work on learning designs and patterns.

In selecting interviewees the principal criteria were that they should include people:

- who had engaged with the specification in many different ways (e.g. developers, educationalists, instructional designers);
- from both public and private organisations;
- from a range of geographical locations around the world; and
- from a range of research communities.
- The interviews were carried out in July and August 2011. The target length of the interviews was 45 minutes. Information gathering commenced with a request for background information on the interviewee's work with IMS-LD. This was followed by discussion of five topics:
- original hopes for the specification;
- experiences of researching into or with IMS-LD;
- satisfaction with the results;
- explanations for the successes and failures; and
- opportunities for the future (with or without the specification).
- Each topic was addressed by:
- closed questions requiring a Likert scale response, for example: On a scale of 1 to 5, how helpful was IMS-LD to you in achieving your goals in your own work, where 1 is 'it was an obstacle to be overcome' and 5 is 'it was the key to success' and
- semi-structured interview questions eliciting each interviewee's reflection on their experience, for example: From your experience of your own work, how did IMS-LD help you or hinder you in achieving your goals? Why do you think this was?

Finally the interviewee was asked for any other comments. Once the interview had been concluded, it was transcribed and sent to the interviewee for feedback and correction.

In managing some 60,000 words of transcripts the WEFT Computer Assisted Qualitative Data Analysis Software (CAQDAS) was used. The intent of using CAQDAS was to code the explicit responses to focused questions contained in the transcripts, so that they might be merged into equivalent explanatory mechanisms and to track the evidence for these.

This initial analysis resulted in interviewees' comments on IMS-LD being assigned to about 50 classifications. This was deemed too many to allow a coherent analysis of the problems of IMS-LD and so further analysis was required. To obtain a manageable set of explanations the authors transcribed the 50 classifications onto paper slips, and arranged these into groups. Through a process of experimentation, five principal explanatory themes were identified which covered the great majority of the comments made in the interviews. These generated clearly contrasting explanations and provided a manageable focus for this discussion.

ABOUT THE INTERVIEWEES

Of the 40 people the authors asked to take part in this work, the following 14 people agreed to be interviewed.

- Full Professor Dr Daniel Burgos: Vice-chancellor for Research & Technology, UNESCO Chair on eLearning, Universidad Internacional de La Rioja (UNIR).
- Fabrizio Cardinali: Chief Executive Officer, Skillaware Performance Support Platform; Chief Strategy and Marketing Officer, SedApta Group; former Chair of European Learning Industry Group.
- Dr Michael Derntl: Research Associate, Advanced Community Information Systems (ACIS) Group, RWTH Aachen University.
- Professor Dai Griffiths: Professor of Educational Cybernetics, Institute for Educational Cybernetics, University of Bolton.
- Dr Davinia Hernández-Leo: Professor, Information and Communications Technologies Department, Universitat Pompeu Fabra.
- Dr Mark Johnson: Reader in Applied Research in Education Technology and Systems, Institute for Educational Cybernetics, University of Bolton.
- Professor Patrick McAndrew: Professor of Open Education, Institute of Educational Technology, The Open University.
- Professor Bill Olivier: Professor in Educational Technology, Institute for Educational Cybernetics, University of Bolton.
- Dr Abelardo Pardo: Lecturer, School of Electrical and Information Engineering, University of Sydney.
- Professor David (Dai) Griffiths: Professor of Educational Cybernetics, Institute for Educational Cybernetics, University of Bolton (one of the present authors).
- Dr Hubert Vogten: Senior Technical Scientific Designer, Open University of the Netherlands.
- Scott Wilson: Service Manager, OSS Watch; Assistant Director, CETIS.
- Dr Volker Zimmermann: Managing Director, NEOCOSMO GmbH.
- Dr Imran Zualkernan: Assistant Professor, Department of Computer Engineering, American University of Sharjah, United Arab Emirates.

The list of invited interviewees inevitably reflects the authors' knowledge of the IMS-LD landscape and their personal contacts. Nevertheless the range of participants is wide. The interviewees have consented to being named in this chapter.

RESULTS OF OPEN QUESTIONS

The five principal explanations which were identified during the analysis of the transcripts were:

- IMS-LD's purpose as an interoperability specification became sidelined;
- IMS-LD tries to be all things to all people;
- IMS-LD has not provided teachers and their institutions with compelling reasons to use it;
- IMS-LD places too many demands on teachers, in their practice and in their relationships with institutions and students; and
- IMS-LD's origins in distance learning limit the potential for its widespread adoption.

We now address each of these explanations in turn, discussing some of the comments made, and summarising the context and mechanism which it proposes for the observed failure of IMS-LD to achieve adoption. In doing this we identify the ascribed context within which IMS-LD was to have had an impact; the hoped for mechanism whereby this would be achieved; and the mechanisms which we identify from the interviews which we have carried out.

In this analysis, when we refer to a named source without a citation this indicates that the reference is to one of the interviews which we carried out.

1. IMS-LD's Purpose as an Interoperability Specification Became Sidelined

The fact that EML was adapted as the IMS-LD specification indicates that there was, in 2003, a perception within the educational technology industry that such an interoperability specification was needed. However, several interviewees discussed the way in which the goal of interoperability had not been realised.

Wilson suggested that with only a small number of reference implementations fully supporting IMS-LD the interoperability issue has become irrelevant. This raises the question of why there have been so few fully IMS-LD compliant systems.

Two interviewees had experience of successfully integrating IMS-LD into their companies' commercial products. However they experienced no demand from customers and so IMS-L D either became an optional feature (Cardinali) or did not warrant the resources needed to maintain its inclusion in future releases (Zimmerman). From a commercial standpoint Zimmerman also suggested that customers have little desire to exchange content with other companies which in turn reduces the need for interoperability in this market. This raises the question of how appealing the idea of content exchange is for educational institutions and practitioners and the resulting need for interoperability that this might encourage. It could be that teachers want to engage at a deeper level than a sequence of activities and resources. Pardo speaks of the issue that "there is no way for the receiver to visualise the ideas the other person had" when they created a Unit of Learning.

Cardinali and Hernández-Leo suggested that if one or more of the widely adopted Virtual Learning Environments (VLE), including open source, had incorporated IMS-LD then this might have prompted others to follow suit. Given the influence of community input into such systems, it seems reasonable to suggest that there was insufficient demand to drive this development. Highlighting one national example, Wilson points out that in the UK when BECTA (the now defunct public body promoting the use of ICT in education) defined the essential components of a VLE (BECTA, 2004) there was no reference to the ability to import and export content packages. As Wilson puts it "IMS-LD as a possibly interesting optional quality isn't going to be looked at [by suppliers]" and there was therefore no incentive for commercial VLE suppliers seeking BECTA approval to include IMS-LD or any other kind of interoperability with competitors' platforms. This does not address the issue of widespread adoption outside the UK but does question the value attached to interoperability in one market.

Griffiths argued that the need for interoperability had changed since the publication of the specification.

> Very few people are shifting courses between institutions. They do not seem to find a need to move activities between systems. This may just be a signal that they use pretty straightforward activities. If you took the universities in the UK I would guess that 90% of them are using either Blackboard or Moodle. When the specification was passed we expected that there would be an increasing number of VLEs rather than this massive concentration of the market. The use case for LD being an interoperability specification has kind of disappeared.

There may also be issues of interoperability when diverse systems make demands of IMS-LD that the specification cannot support. Derntl spoke of the difficulty of maintaining interoperability in customised environments and of problems encountered when a Unit of Learning (UoL) contained additional metadata outside of the specification. Attempting to translate the needs of such a customised environment into something supported by IMS-LD could present an onerous or unfeasible task. Addressing this issue, respondents spoke about the lack of IMS-LD compatibility in existing VLEs and that, where this functionality is included, it feels like a plug-in rather than being smoothly integrated.

The above comments focus on the lack of effective interoperability as a cause for the lack of adoption of IMS-LD. In terms of realistic evaluation, we can distinguish the following explanation.

Context. A perceived need for an interoperability format for elearning courses.

Hoped for mechanism. Once the capability for exchanging UOLs becomes available, users will demand this functionality in their VLEs, and providers will seek to obtain competitive advantage by providing it.

Observed mechanism. IMS-LD implementation was complex (Derntl; Zimmerman), and so there was resistance to adoption from providers. From the other side VLE customers did not express a strong need to exchange courses (Cardinali; Zimmerman; Wilson). Increasing concentration of the VLE market meant that interoperability was a less urgent need for users and providers. Therefore the hoped for demand for interoperability did not materialise, and consequently IMS-LD did not achieve adoption.

2. *Ims-Ld Tries to Be All Things to All People*

The IMS-LD Specification document (IMS Global Learning Consortium Inc, 2003b) states that it constitutes "a generic and flexible language" which enables "many different pedagogies to be expressed." It is stated that this approach has the advantage that "only one set of learning design and runtime tools then need to be implemented in order to support the desired wide range of pedagogies." However, there are indications from the interviews that this generality may also cause difficulties. Pardo reported that IMS-LD's neutrality increased the difficulty of creating a runtime environment. Vogten also spoke of the issues he faced in creating a reference implementation of IMS-LD, in this case the CopperCore runtime engine, and how he felt that integrating IMS-LD into an existing system might be simpler.

> It's trying to make a design starting with the first metadata, ending with the whole process and describing everything in between. This makes it a strong specification because when you have a finished design everything you want to achieve is captured in its manifest which is nice. But it makes integration with existing systems very difficult because it has an expectation of how a system should work rather than taking a system as it is and bolting on some new things which other specifications were doing.

Griffiths argued that the desire to make the specification as expressive as possible may have made it unmanageable.

> We have got a great big specification which includes environments, activities, resources and people management. It might be that if you were starting today you might not put all those elements inside a single server or even inside a single specification. You might have a little family of specifications which work together, each or which have their own servers.

Discussion of complexity extended beyond tools and into conceptual issues. Interviewees questioned whether, by attempting to satisfy all possible needs, simple and complex, IMS-LD fails to address either of these particularly well. Derntl found that, despite the sophistication and completeness of IMS-LD it still did not support all his needs. Hernández-Leo also saw “the complexity for some and the incompleteness for others” as a barrier to the use of IMS-LD. Derntl also questioned “where does all the sophistication help if it doesn’t support some of the very simple things?” Wilson felt that a lack of clarity about IMS-LD’s purpose meant that “by addressing such a broad range of potential uses you actually made it more difficult for any of them.” Wilson also felt that compromises in IMS-LD’s design, carried out to appease political pressures, increased the complexity of the specification and also suggested that the origins of IMS-LD may have contributed to the lack of adoption.

> When you have a very principled view you can end up producing a specification that can’t be implemented but which embodies your principles. I think IMS-LD embodies a lot of those principles but didn’t in my view produce anything that is commercially implementable.

Richards and Wilson both spoke of the merits of starting with simple systems with a more limited set of features. Simpler alternatives to IMS-LD have been suggested, for example by Durand, Belliveau and Craig (2010) and Wilson (2010). While further exploration of alternatives to IMS-LD is beyond the scope of this discussion, Derntl raised the possibility of using a subset of IMS-LD in the design of tools to support specific use cases. Pardo also reported success obtained by a PhD student using a modified version of IMS-LD to suit their purposes. However, this kind of development, which reduces the compatibility of systems, seems to further undermine the relevance of IMS-LD as an interoperability specification. Derntl’s experiences, as outlined earlier, reflected this.

Context. A perceived need for a specification which would enable a wide range of pedagogic structures to be expressed.

Hoped for mechanism. A highly expressive specification would lead to the implementation of systems which could implement any pedagogy. These would provide attractive functionality which would drive adoption.

Observed mechanism. The goal of supporting any pedagogy in a single specification resulted in barriers to implementation and usability which had not been anticipated, and so generated barriers to adoption.

3. IMS-LD Has Not Provided Teachers and Their Institutions with Compelling Reasons to Use It

IMS-LD was intended to “support mixed mode (blended learning) as well as pure online learning” (IMS Global Learning Consortium Inc, 2003a). It was posited that teachers would be helped by computerising some of the task of classroom coordination; Koper and Olivier (2004), drawing on Howell, Williams and Lindsay (2003) state that "faculty members demand decreased workloads, especially while working with learning management systems or online collaborative and conference environments. More automated support in the work process of faculty members is needed." Similarly Griffiths reflected on his own engagement with IMS-LD, saying that he was trying to achieve an "enhancement or transformation of elearning where things would be more flexible and we would have new opportunities for elearning." However, the interviews indicate that teachers have not recognised benefits in the use of IMS-LD. The lack of IMS-LD success stories and good example content that might motivate teachers to engage with IMS-LD was discussed by several respondents, for example Burgos:

> You cannot highlight any proof of concept or actual outcome and say 'you can do this, if you put all this effort in then you will have something amazing here in front of you'. And the teachers or instructional designers can answer that maybe it is worth it even when the learning curve is steep, long and rough. However, you cannot show anything really attractive and useful enough for them to invest so much time and effort to make it.

Derntl also supported the need for success stories and stated the importance of identifying the best use cases for IMS-LD as part of this process.

> What is needed is a testbed where IMS-LD is tested in different institutional settings and in different pedagogical settings to reach an empirically supported recommendation on where to use IMS-LD and where not to use it.

Cardinali further suggested that too much focus has been placed on producing IMS-LD tools and that "this meant that little investment of time, capacity and skills was made in the front end richness of content production."

Derntl described the lack awareness he encountered amongst managers in Higher Education (HE) both of IMS-LD specifically and more generally "the opportunities of describing teaching practice." This suggests that the problem could extend beyond IMS-LD to any specification or application which sets out to document teaching practice. Similarly Zimmerman said that businesses are not interested in documenting their detailed learning processes.

> They [businesses] don't want to talk on this level and so it's too much overhead which does not reflect scenarios where you have ad-hoc learning. Everything must be predefined at a too granular level and that's also an issue for businesses.

Context. A perceived need for technology to support teachers in their practice.

Hoped for mechanism. By demonstrating more flexible and effective elearning, teachers and institutions will be drawn to IMS-LD.

Observed mechanism. It proved too difficult to make convincing demonstrations of the functionality of IMS-LD, and the level of analysis of learning activities required in authoring was more detailed than that which teachers were comfortable with. Consequently they did not engage with IMS-LD.

4. IMS-LD Places Too Many Demands on Teachers, in Their Practice and in Their Relationships with Institutions and Students

The previous section identified the lack of a motivation to use IMS-LD among teachers and other actors. Additional barriers were identified which stood in the way of adoption. In 2003 one of the present authors wrote, it now seems with excessive optimism, that

> The ease of use of applications and pedagogic support for teachers is gradually improving, and we are confident that this trend will continue in the future. The ultimate goal is to enable users to focus purely on learning and teaching, perhaps being completely unaware that they are using Learning Design and other specifications. (Griffiths, 2003)

Comments in the interviews and our own observation indicate that this has not come to pass. Vogten related this to IMS-LD's assumption of "a kind of publisher model where you have a very structured thing but also a very structured way of producing courses," and expressed some doubt whether it was possible to implement a powerful and easy to use IMS-LD editor that supported all the richness of the specification. Similarly Pardo reported that teachers struggled to work with the specification even when provided with "tools that hid most of the details." Hernández-Leo felt that runtime tools were a particular cause of problems, and were not mature enough to be used in real settings.

The result, according to Richards, was that

> When you document using any process it is because you are hoping that the documentation of the process is going to give you some return on investment at some point in the future. … But to actually do anything with it or use any of the tools it became increasingly complex and it just became one of those things where we said 'well, there must be a simpler way of doing this than going through all these things'.

This was echoed by Vogten: "if you have that heavy process on a fairly simple course you don't get a return on investment."

Olivier, suggested that, to be adopted in mixed mode learning, IMS-LD requires a considerable change to the ways in which teaching staff operate within and are supported by their institutions.

> You've got to be able to say members of staff 'I want you to stop teaching for the next semester and prepare a module and when we do that we are going to

> use it intensively with a lot of students afterwards.' We don't get the time. We're not set up to do that.

Looking now at end users, this comprehensive approach might also affect a teacher wanting to use IMS-LD in their teaching practice. Pardo suggests that IMS-LD requires teachers to work at too granular a level.

> A useful analogy is that if we asked computer programmers to write computer programs in zeroes and ones again they would tell us that this is not feasible. This analogy is a little bit extreme but it is just to point in the direction that I like to highlight, which is LD can be very expressive. The problem is that expressing an everyday learning experience in the terms of LD is too complex.

There is a question of whether end users should see the complexity of the specification at all. Olivier spoke of the need for a graphical authoring tool with complete IMS-LD support and that tools such as RELOAD and ReCourse could be easier to use. However Vogten felt that producing a powerful, easy to use and fully IMS-LD compliant authoring tool was "a contradiction in itself" and would be a difficult undertaking.

Interviewees also raised the issue of how IMS-LD challenges the role of teachers. Olivier suggested that IMS-LD shifts teachers from "being the source of wisdom for students to being their learning facilitator" instead. Johnson identified a similar, but perhaps opposite challenge, in balancing the formal requirements of education with the rich relationships they form with pupils.

> So basically you've got a whole education system moving into this very engineered world. Naturally enough the teachers, whose job is not actually to work the formal system but to do the soft stuff, rebel against it. They don't recognise their job as the one that's being prescribed for them in the tools.

Context. Substantial resources were dedicated to the development of IMS-LD infrastructure.

Hoped for mechanism. The complexity of the specification would become irrelevant if sufficiently well designed tooling was available, which would enable UOLs to be created and run easily.

Observed mechanism. The development of IMS-LD systems proved more challenging than anticipated, and UOLs time consuming to document and create. The use of technology in teaching activities did not prove neutral, and provoked resistance among some teachers. The investment of time and effort was not compensated by benefits to teachers and institutions. Consequently levels of adoption remained low.

5. IMS-LD's Origins in Distance Learning Limit the Potential for Its Widespread Adoption

As stated above, IMS-LD was intended to "support mixed mode (blended learning) as well as pure online learning" (IMS Global Learning Consortium Inc, 2003a). Its origins, however, were in the Open University of the Netherlands EML, and some respondents felt that this had constrained the potential adoption of IMS-LD. Firstly although the specification makes no statement about how it should be implemented, many interviewees identified issues with the available implementations of IMS-LD which might be associated with distance learning approaches.

More fundamentally, the separation of design and runtime was suggested as a problem. As Derntl says, "at design time you have to be over specific for things you probably don't even know yet and at runtime you cannot do anything." This statement highlights two separate issues. First there is what Pardo identified as "the convoluted process to create a UoL," and Vogten's observation that "the tools that are available are quite heavy and still very production like; preparing, pre-publishing, finally publishing and reviewing a lot." Secondly, interviewees identified a lack of flexibility at runtime which makes it difficult for UoLs to be easily adjusted by teachers during lessons, as illustrated by Pardo.

> For example if I have my class organised in teams but half way through the class I have to change the teams because three people just left the class and dropped the course I need to change that in a matter of five minutes' work. In a UoL that is a major re-organisation.

Derntl felt that these constraints corresponded to the needs of distance teaching, but limited the breadth of appeal of IMS-LD.

> This restricts the potential users significantly. I would say it's only useful if you are a distance university where you have a broad body of teachers and tutors and you want to do a massive rollout of new or existing courses which are highly structured and standardised. Then it's probably perfect to use it. But for most HE teaching contexts, like classic universities, it's difficult because teaching is more or less a back and forth process introducing new things and being flexible at runtime.

One possible response is that these issues are caused by the available tools. Olivier felt that, from a runtime perspective, the problem lies in the implementations of IMS-LD and that this issue might be resolved "if you were just interpreting the unit of learning as you go along and you got to a certain point where you wanted to change something, then you could." However Pardo talked of the "difficulty of changing the UoL significantly and trying to maintain the internal structure." Indeed, no system was mentioned by our respondents, or is known to the authors, which enables teachers to respond to unexpected events in the classroom by making spontaneous changes to a carefully crafted UoL.

Context. Extension of a distance learning methodology to a wider pedagogical context.

Hoped for mechanism. Pedagogically neutral and abstracted descriptions of learning activities would be equally applicable in distance and face-to-face contexts.

Observed mechanism. Many of the respondents believe that IMS-LD carries with it characteristics which make it less appropriate for face-to-face teaching. This has limited its potential adoption.

RESULTS OF LIKERT QUESTIONS

Given the small sample size it seems unwise to attach too much significance to the Likert responses. In addition to this some respondents were unable or preferred not to give answers to some of the questions. However, there were interesting responses to questions addressing the level of happiness with the results of their work, the extent to which IMS-LD helped them achieve their goals and the value of the introduction of IMS-LD. Several respondents were keen to score these questions separately for both their research contexts and for their 'real world' engagement with practitioners. The scores given were higher for research than for the 'real world'.

> It's difficult. I'll give it a 3 but with a qualification. It clearly provided a useful tool for researchers and it provided a very useful tool for a lot of PhD students in developing their work and for projects researching various areas related to group activity. So as a research tool I think it was quite successful. As a tool for education I think it wasn't successful at all. (Wilson)

Given that this study hoped to uncover some of the reasons for IMS-LD's lack of widespread adoption it should maybe not come as such as surprise that people did not think IMS-LD had fared as well with practitioners as it had in the research community.

We discuss a second pattern in the Likert question responses in the conclusions.

CONCLUSIONS

It seems clear from the interviews that there is no one answer as to why IMS-LD has not been widely adopted. Interviewees identified a range of often interconnected issues that they feel have limited the appeal of the specification. Some of these issues relate to technical issues, which might be 'fixed' with appropriate attention, although interviewees disagreed about the degree to which this might be possible. Interviewees also identified issues involving human interaction which are harder to address, such as the degree to which IMS-LD can be adopted without asking teachers, students and their institutions to change their working practices. In areas such as this the problems raised by IMS-LD are less about the specification itself and its implementation, and more about the complexity of its effects on human interactions. This has implications that extend beyond issues of IMS-LD's 'completeness' as a specification or the value of interoperability, and which are of wider relevance to the work on learning design and patterns.

The complex interactions between these wide ranging issues have resulted in more questions than answers and the extent of the conversations that fed into this study means that there is far more to unpack and discuss than we could hope to cover here. However in our analysis of the interviews, and the identification of the five theories about IMS-LD's lack of widespread adoption which we most frequently encountered in them, we hope to have distilled the richness of this combined narrative and provided a fair representation of the majority of points raised by interviewees. It is our hope that this insight will provide not only a forensic analysis of what went wrong with a promising line of research and development, but also a starting point for discussion of current work in related areas, including that which is described in this volume.

Even eleven years after the publication of the specification, it is not possible to offer a final judgement on the value of IMS-LD. When respondents were asked to score the current prospects for the adoption of IMS-LD, several were keen to differentiate between IMS-LD's immediate prospects and its potential use for an as yet unknown purpose at some point in the future. For example, Richards commented:

> That's a difficult question to answer because times will change. Just because we don't have the capabilities to implement it today doesn't mean that it will not become relevant tomorrow. In the 19th century there was a professor at the University of Cork who was playing around with a very theoretical mathematics and everybody thought it was interesting but nobody thought it was useful. It wasn't until decades later that somebody said 'these electronic valves, maybe we could use this guy Boole's algebra to help resolve some of the issues we are having with these electronic computers.' Of course all of a sudden off the back plate we find Boolean algebra everywhere. So just because it's been a big investment and it may not be the time to make it go forward, given the recession and the economy and this particular date, I think that as an intellectual notion it is very important. I think that it has a future; I just don't know when that future will be.

Whether or not there proves to be future potential for IMS-LD, it remains the case that the specification has not gained widespread traction, and that as researchers in the field of educational technology we will find it valuable to establish why not. Our work reported here is a modest step in this direction. Nevertheless, Richards and other respondents' comments suggest that we would be wise to maintain an open mind as to the future value of the significant achievements of IMS-LD.

REFERENCES

Alexander, C., Ishikawa, S., & Silverstein, M. (1977). *A pattern language: Towns, buildings, construction* (Vol. 2). USA: Oxford University Press.

BECTA (2005). *The learning platform comformance regime version 2.4*. Retrieved from http://www.school-portal.co.uk/GroupDownloadFile.asp?GroupID=65369&ResourceId=249373

Buzza, D., Bean, D., & Harrigan, K. (2004). Learning design repositories: Adapting learning design specifications for shared instructional knowledge. *Canadian Journal of Learning and Technology*, *30*(3). Retrieved from http://www.cjlt.ca/index.php/cjlt/article/viewArticle/135

Dalziel, J. (2003). Implementing learning design: The learning activity management system (LAMS). In G. Crisp, D. Thiele, I. Scholten, S. Barker, & J. Baron (Eds.), *Ascilite* (pp. 293–296). Adelaide, Australia: Citeseer.

Derntl, M., Neumann, S., Oberhuemer, P., Tattersall, C., Verpoorten, D., & Klemke, R. (2009). *Report on the standardized description of instructional models*. Retrieved from http://www.icoper.org/deliverables/ICOPER_D3.1.pdf

Derntl, M., Neumann-Heyer, S., Griffiths, D., & Oberhuemer, P. (2012). The conceptual structure of IMS learning design does not impede its use for authoring. *IEEE Transactions on Learning Technology*, *5*(1), 74– 86.

Durand, G., Belliveau, L., & Craig, B. (2010). Simple learning design 2.0. In M. Jemmi, Kinshuk, D. Sampson, & J. M. Spector (Eds.), *ICALT 2010: Proceedings of the 10th International Conference on Advanced Learning Technologies* (pp. 549–551). Sousse, Tunisia: IEEE Computer Society. doi: 10.1109/ICALT.2010.156

Griffiths, D. (2005). Teachers and learning design. In D. Burgos & D. Griffiths (Eds.), *The UNFOLD project: Understanding and using learning design* (pp. 31–34). Heerlen, Netherlands: Open University of The Netherlands.

Griffiths, D. & Liber, O. (2008). Opportunities, achievements, and prospects for use of IMS-LD. In L. Lockyer, S. Bennett, S. Agostinho, & B. Harper (Eds.), *Handbook of research on learning design and learning objects: Issues, applications, and technologies* (pp. 87–112). Hershey, PA: IGI Global.

Hermans, H., Manderveld, J., & Vogten, H. (2004). Educational modelling language. In W. Jochems, J. van Merrienboer, & R. Koper (Eds.), *Integrated e-learning: Implications for pedagogy, technology and organization* (pp. 80–99). London, UK: RoutledgeFalmer.

Howell, S. L., Williams, P. B., & Lindsay, N. K. (2003). Thirty-two trends affecting distance education: An informed foundation for strategic planning. *Online Journal of Distance Learning Administration*, *6*(3). Retrieved from http://www.westga.edu/~distance/ojdla/fall63/howell63.html

IMS Global Learning Consortium Inc. (2003a). I*MS learning design information model, Version 1.0*. Retrieved from http://www.imsglobal.org/learningdesign/ldv1p0/imsld_infov1p0.html

IMS Global Learning Consortium Inc. (2003b). *Learning design specification.* Retrieved from http://www.imsglobal.org/learningdesign/

Konig, F., & Paramythis, A. (2010). Closing the circle: IMS-LD extensions for advanced adaptive collaboration support. In F. Xhafa, S. Demetriadis, S. Caballé, & A. Abraham (Eds.), *INCOS 2010*: *Proceedings of the 2nd International Conference on Intelligent Networking and Collaborative Systems* (pp. 421–426). Thessaloniki, Greece: IEEE. doi:10.1109/INCOS.2010.83

Koper, R., & Olivier, B. (2004). Representing the learning design of units of learning. *Educational Technology and Society*, *7*(3), 97–111.

Koper, R., & Tattersall, C. (2005). *Learning Design: Modelling and implementing network-based education & training*. Berlin, Germany: Springer Verlag.

Monfort, V., Khemaja, M., & Hammoudi, S. (2010). Extending the IMS-LD standard with Adaptability. In M. Jemmi, Kinshuk, D. Sampson, & J. M. Spector (Eds.), *ICALT 2010*: *Proceedings of the 10th International Conference on Advanced Learning Technologies* (pp. 549–551). Sousse, Tunisia: IEEE Computer Society. doi: 10.1109/ICALT.2010.91

Pawson, R., & Tilley, N. (1997). *Realistic evaluation*. Thousands Oaks, CA: Sage Publications Inc.

Reigeluth, C. M. (1999). The elaboration theory: Guidance for scope and sequence decisions. In C. M. Reigeluth (Ed.), *Instructional design theories and models: A new paradigm of instructional theory*, (pp. 5–29). Hillsdale, NJ: Lawrence Erlbaum Associates.

Wilson, S. (2010, April 22). *Simplifying learning design* [Blog post]. Retrieved from http://zope.cetis.ac.uk/members/scott/blogview/index-entry=20100422130555.html

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10. A CRITICAL REVIEW OF IMS LEARNING DESIGN

Recommendations for a Revised Version

INTRODUCTION

The work presented in this paper summarizes the research performed in order to implement a set of Units of Learning (UoLs) focused on adaptive learning processes, using the specification IMS Learning Design (IMS-LD). Through the implementation and analysis of four learning scenarios, and one additional application case, we identify a number of constraints on the use of IMS-LD to support adaptive learning. Indeed, our work in this paper shows how IMS-LD expresses adaptation. In addition, our research presents a number of elements and features that should be improved and-or modified to achieve a better support of adaptation for learning processes. Furthermore, we point out to interoperability and authoring issues too. Finally, we use the work carried out to suggest extensions and modifications of IMS-LD with the final aim of better supporting the implementation of adaptive learning processes.

A BRIEF DESCRIPTION OF THE IMS LEARNING DESIGN

IMS Learning Design (or simply IMS-LD) (IMS, 2003) is aimed to transform regular lesson plans into interoperable Units of Learning (UoL). This specification is able to use any pedagogical model to get a UoL run-able and editable in an interoperable way. IMS-LD augments other well-known e-learning specifications aforementioned, like SCORM, IMS Content Packaging, IMS Question and Test Interoperability or IMS Simple Sequencing. Furthermore, IMS-LD provides a language to describe the teaching and learning process in a Unit of Learning. It describes among other things the roles, the activities, the basic information structure, the communication among different roles and users; and all these under the pedagogical approach decided by the teacher and-or the learning designer. In this section, we show what is IMS-LD and how it is structured, as well as how it provides Adaptation within the UoLs

IMS-LD is able to describe a full learning flow with several elements -such as roles, activities, environments or resources- and features -such as properties, conditions, monitoring services or notifications (Burgos & Griffiths, 2005; Koper & Tattersall, 2005).

M. Maina et al. (Eds.), The Art & Science of Learning Design, 137–153.

The usual life-cycle starts with a lesson plan modelled according to the IMS-LD specification, defining roles, learning activities, services and several other elements, inside an XML document called Manifest. An information package written in IMS Content Packaging (IMSCP, 2001) is used as a container for the resources and links them with the IMS-LD structure. Later, the Manifest is packaged with the nested resources in a compressed ZIP file, meaning a UoL. Several examples available are shown later on.

IMS Learning Design uses the metaphor of a theatrical play to visualize how to model Units of Learning. A play is performed by a number of actors, who may take up a number of roles at different times in the play. Similarly in learning design a learner can take up different roles at different stages of a learning process. At the end of each act the action stops, all the learners are synchronised, and then a something new can begin.

IMS-LD consists of three levels: Level A, with the definition of the method, plays, acts, roles, role-parts, learning activities, support activities and environments. It is the core of the specification, contains the description of the elements that configure IMS LD and the coordination between them. For instance, role-parts define what activities must be taken by a role in order to complete an act and, subsequently, a play.

Level B, adds properties, conditions, calculations, monitoring services and global elements to Level A, and provides specific means to create more complex structures and learning experiences. Properties can be used as variables, local or global ones, storing and retrieving information for a single user, a group or even for all the characters involved. Through these mechanisms the learning flow can be changed at the run time, as decisions can be made taking into account dynamic content. Logically it is the used level to express the most of the pedagogical needs concerning Adaptation, personalization, feedback, tracking and several other usual requests of teachers and learning designers.

Finally, Level C adds notifications to Level B, meaning an email sent and a show/hide command to a specific activity, depending on the completion of another one (Koper & Burgos, 2005).

IMS-LD AND ADAPTATION

In addition to the basic structure of Level A, the elements in Level B and Level C are actually the key for more expressive UoLs (for instance, based on Adaptation or Collaboration), as they combine several features that encourage and make the content and the learning flow more flexible (Koper & Burgos, 2005). Furthermore, the combination of these elements allows for the modelling of several classical adaptive methods (i.e. reuse of pedagogical patterns, adaptability, navigational guidance, collaborative learning, contextualized and mobile distributed learning, Adaptation to stereotypes), making use of different structural elements of IMS-LD, like i.e. Environment, Content, User groups and Learning flow (Burgos et al., 2007).

In a literature study, we identify eight different kinds of Adaptation being carried out in eLearning systems (Burgos, 2008): Interface based, Learning flow based, Content based, Interactive problem solving support, Adaptive information filtering, Adaptive user grouping, Adaptive evaluation, and Changes on-the-fly. All of them use various inputs provided during the learning process and aim to tune the activities and actions of the learner to get the best learning experience as possible (Butz et al., 2003). A wide and consistent set of rules of dependencies among users, methods and learning objects is needed to describe these eight types of Adaptation, and moreover their possible combinations. If we categorize all these types of Adaptation, we can group them in two clusters (Ahmad et al., 2004; Chin, 2001; De Bra et al., 2004; Baeza-Yates & Ribeiro-Nieto, 1999; Van Rosmalen & Boticario, 2005; Merceron & Yacef, 2003; Romero et al., 2003). The first one consists of three types of Adaptation:

1. Interface-based (also called adaptive navigation and related to usability and adaptability) where elements and options of the interface are positioned on the screen and their properties are defined (color, size, shadow, etc.); this is closely related to general customization and supporting people with special needs which influence personalization, such as colour impairment or poor hearing, for instance.
2. Learning flow-based, where the learning process is dynamically adapted to sequence the contents of the course in different ways. The learning path is dynamic and personalised for every student, but even also for every time that the course is started (also called run or instance), so that the student can take a different itinerary depending on his performance.
3. Content-based, where resources and activities dynamically change their actual current content, as in Adaptive and Intelligent Web-Based Educational Systems based on adaptive presentation (Brusilovsky & Miller, 2001). For instance, the information inside a learning activity can be classified in three levels of depth, and every level is shown based on a number of factors.

The first cluster with three types of Adaptation becomes the base for the next one. Additional kinds of Adaptation feed a second cluster: 4) Interactive problem solving support; 5) Adaptive information filtering, 6) Adaptive user grouping; 7) Adaptive evaluation; and 8) Changes on-the-fly.

METHODOLOGY OF ANALYSIS

This section describes how we have carried out the analysis, as well as the methodology followed to do the research in this paper. Previously, we have described how adaptation is envisaged by IMS-LD and which types of adaptation can be expresses with this specification. Furthermore, we have described, modelled and implemented a number of Learning Scenarios which show features for adaptive learning processes.

First, we have defined, modelled and analysed five Units of Learning (UoLs), which are described as learning scenarios (Table 1). In these learning scenarios, we describe adaptive learning processes and features. Further, we carried out an analysis of a real application case from the ATOS University, where a Unit of Learning (UoL) with adaptation features modelled with IMS-LD, was implemented (Figure 1).

Table 1. Learning scenarios

ID	*Type of adaptation*	*Description*
1	Adaptive Assessment	adaptation on the learner´s performance and knowledge
2	Adaptive Authoring	adaptation on the learning designer´s method
3	Adaptive Content	adaptation on the learner´s decision
4	Adaptive Mentoring	adaptation on the teacher´s decision
5	Combination of adaptive types	Application case on Corporate training

Last, every learning scenario is analysed and reports on shortcomings and recommendations to improve the expressiveness of IMS Learning Design to achieve a better adaptation process. These scenarios are focused on every single adaptation feature that makes a recommendation useful on the learning itinerary of a user. On this regard, they go from assessment to content, through authoring or mentoring. What every scenario provides is a setting to test this specific adaptive feature on a group of users. For instance, on Adaptive content, the user is entitled to select a resource (e.g. PDF file) out of a list of available files in a repository which are selected by the system for the user based on his/her inputs like, i.e. performance or background profile. On the tutor's side, on Adaptive mentoring, the teacher-tutor gets a set of actions to take on a user or user group to increase their skills, knowledge or competences. These actions are designed on the basis of the user's inputs like, i.e. group interaction, response time or previous selections. The tutor will have the last word to take the decision, independently or guided by the recommendations report.

Our analysis is focused on the main challenges and limitations to performing adaptive learning with IMS-LD. These mainly focus on the need for improving the flexibility and interoperability of this specification, while model-ling adaptation.

All of them are available at the GRAPPLE Project website (http://www.grapple-project.org)

HOW IMS-LD EXPRESSES ADAPTATION

In this section, we examine how IMS-LD can be used to represent each of the eight types of Adaptation afore-mentioned. A combination of the following proposals on Adaptation could support the performance of every role in an eLearning process.

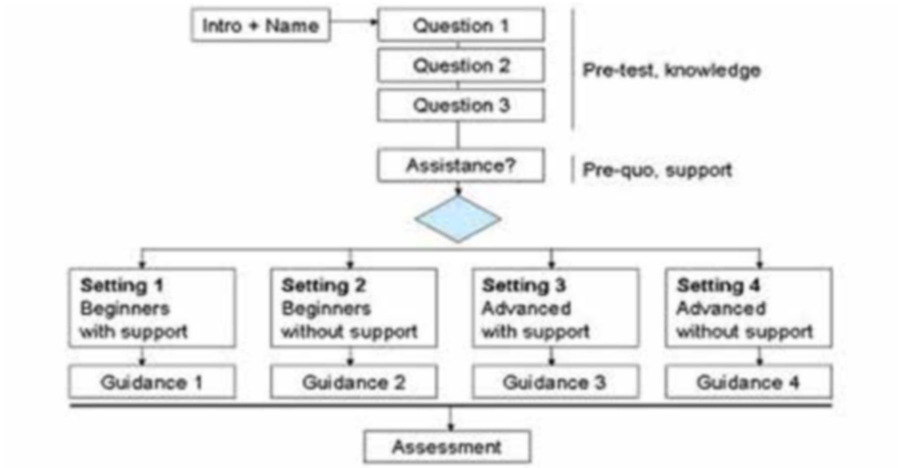

Figure 1. ATOS application case

Taking the first block (which consists of the three main types), IMS-LD is able to model Adaptation.

Adaptation Based on the Interface

Interface Adaptation is based on options, navigation and visualization facilities. Interface Adaptation is not possible with today's tools for IMS-LD, such as CopperCore Player (Vogten et al., 2006). As long as the Adaptation of the interface is based on the tool and not on the Unit of Learning that is interpreted by the player, this is still true. Today's players do not yet provide facilities to change the size or the position of the navigation panels, or even open and close the working areas in the player. Either, these tools cannot change the style sheets related to a HTML file, part of the content, and any of the linked features, as font-size, font-type or background colour, for instance. Although the CopperCore engine provides the appropriate infrastructure, no player uses it so far. Nevertheless, some kind of adaptive interface is possible, using DIV layers and environments.

Adaptation Based on the Learning Flow

The modification of the learning flow as the Unit of Learning is being executed is one of the most often used types of Adaptation. Taking the flow as a base, the Unit of Learning provides different activities, resources and services, depending on these four inputs during execution (user's behavior and performance, user´s decision, teacher and set of rules). The activity structure in an IMS-LD UoL is defined using plays, acts, activity structures, learning activities, support activities and environments. We can also use the property of visibility to hide and show these elements and to adapt the learning flow. In these cases the property works as a flag, switching on and off the elements referred to.

Adaptation Based on the Content

Content Adaptation is based on the information inside an activity that is shown and handled. We know that a learning flow is mainly focused on the sequence of the activities in a Unit of Learning. However, content based Adaptation is focused on the information of every activity, and on the activity itself. There are two main approaches for content based Adaptation in IMS-LD: Flag properties and content of properties. Flag properties hide and show elements like e.g. activities or environments. On the other side, the content of specific properties can be modified on the run, making use of global elements in the specification.

Elements in Levels B and C to Model Adaptation

The elements in Level B and Level C providing support to Adaptation in Units of Learning are categorized as a) properties, b) conditions, c) global elements, d) calculations, e) monitoring services, and f) notifications (Koper & Burgos, 2005; Burgos & Specht, 2006):

1. Definition, set-up and use of properties: Properties are taken as variables to store values. There are several types of properties: local, local-personal, local-role, glob-al-personal, global. There is also a property-group that is able to compile a number of the others.
2. Conditions: IMS-LD is able to define a basic structure if-then-else, or multiple structure with several chained basic if-then-else in a row, for instance to change the value of a property or to show and hide one element.
3. Global elements: Global elements provide a communication flow between the imsmanifest.xml, where the different levels of IMS-LD are set-up, and other XML files. Mainly, they can get an input from the user and they can show a value of a property. Furthermore, they can manage DIV layers in XHTML, for instance to show and hide specific content.
4. Calculations: IMS-LD is able to make some basic arithmetic's (sum, subtraction, multiplication and division) and some combination of a number of them in a row, to get a more complex formula, like a simple average, for instance.
5. Monitoring service: The specification allows monitoring any kind of property assigned to a user or a role, for instance. In order to start this action, firstly the component monitor must be set-up inside an environment and later the property can also be monitored.
6. Notifications: An action is automatically launched de-pending on the state of a property or a previous action, i.e., when a student ends an assignment an email is sent to the tutor.

IDENTIFICATION OF CONSTRAINTS, GAPS AND ISSUES TO COPE WITH

We use every learning scenario aforementioned as a base to find restrictions, drawbacks and elements to improve within the specification. These resources show how far IMS-LD supports adaptation, when different inputs and roles are involved. We also make links to the integration of UoLs, when needed. Out of the modelling and development of those UoLs we perform an analysis on which features, elements and components are missing or could be modified in order to achieve a more adaptive and expressive-oriented general definition, with the ultimate aim of improving the specification and bringing it closer to actual needs on eLearning.

In this section, we provide a detailed analysis of what IMS-LD can and cannot model, in its current information model, with regards to adaptation. This analysis concentrates on the weak points and main features of every learning scenario. These remarks will be addressed to produce a set of recommendations (i.e. extensions and modifications) to improve the pedagogical expressiveness on IMS-LD, focused on adaptation, in the next section.

Following, we summarize our main findings. With regards to the specification itself:

- The definition of properties and the link through several working XML files is too complicated to become useful
- The relation between layers and actions is not straightforward and it has to be done interlacing files, through global elements and XML
- The lack of a richer conditional structure makes the editing of the set of rules more complicated on paper than they actually are from a rational point of view
- Controlled iterations in the activities are not allowed. Furthermore, a closed activity cannot be re-initialized and/or go backwards
- The monitoring service doesn´t cover any kind of user grouping. Therefore, a user (e.g. either a teacher or a learner) cannot follow the performance of several other users at the same time
- Questions and answers are not personalised for user; they are identical for all users with the same role
- The communication between teacher and student is little and indirect. They can view the values of properties but there is no other communication service between them
- There is a lack of flexibility in the input point of changing the itineraries. In the type Sequence, the learning activity with the question appears always at the same place. In the type Selection, the question is always presented after 2 completed learning activities. In case the learning designer/teacher wants to shift this input point, they cannot do so
- There is no possibility to handle absolute time to start the course and/or a specific activity. Only relative time to the precise time when the instance is created out of the UoL, it is possible

- There is no chance to make a connection to an al-ready existing database (for instance, to make a query or to import already enrolled students or teachers). The data type of connection is not supported. Therefore, every enrolment has to be done by hand or running a specific tool for that
- Furthermore, any connection with the external world is impossible. For instance, a real-time effective communication between an LMS and an IMS-LD UoL is not possible so far, so that in fact they cannot benefit each other from mutual services and resources. There is no foreseen dispatcher or service in the specification allowing such connection (Moreno et al., 2007)
- When an executable module is developed with other technologies (Macromedia Flash and PHP, for instance), it cannot be integrated with IMS-LD in any way. Therefore, we also identified an interoperability problem. Although IMS-LD is not developed with the intention of supporting such interactivity with users, it could allow for a valid integration with external resources using a layer of communication/dispatcher.
- A file uploaded from the hard disk of a computer is stored in a file-type property inside the internal database of the engine (CopperCore, in this case). There is no possibility to change the default configuration for storing or retrieving resources. There is no facility to manage those uploads either. Although this is an issue concerning tools too, the core documents of IMS-LD do not provide this information and/or service either
- IMS-LD does not allow saving information into external files or retrieving information from any external source
- To perform a dynamic user selection in order to create groups is not possible. The teacher can monitor each user, and provide him/her with some feedback on a personal basis. We could set-up a property to be dealt by groups, but these groups should be established before the actual start. However, if the teacher wants to make a dynamic creation of a group of students depending on their answers, this is not possible so far. To this extent, groups and roles are the same thing
- IMS-LD does not allow for recording the user's behaviour; in fact, no measures (i.e., Total Time Needed, Time Before First Move) can be restored or retrieved
- As a consequence, adaptation based on the user´s behaviour cannot be developed using the IMS-LD specification. Furthermore, the current state of tooling does not support it either

1. In addition, with regards with the current engines, we highlight a few issues that would support a more powerful use of the specification:

- Changes on-the-fly are not possible. In case that the teacher or the learning designer wants to change i.e. the questions, the answers, or the content of the next activity to be carried out, they find that. Every single resource has to be packed in design and publishing time before the actual running of the instance

- In questionnaires and other forms with fields, the teacher/learning designer cannot modify the number of questions or answers, once the UoL has started
- There is no option to run the UoL (the whole UoL or a part, such a Learning Activity) twice within the same instance. Once a Learning Activity is closed, the user can read it again but the associated learning flow cannot be executed. For instance, after the question to change the itinerary is made in the historic-route, there is no way to go back
- There is no flexibility to change the content. When the teacher/learning designer wants to keep the same method and the same structure, but he/she wants to change one single HTML page with some content, the UoL has to be validated and published again. In this case, the learner and the teacher would have to be enrolled and the learning process starts from the very beginning
- Users cannot be dynamically enrolled within the UoL, once it has started, and they have to be managed by an external tool

FURTHER ANALYSIS

In the next section we show specific recommendations which deal with extensions, modifications of modelling structures, elements and components, as well as with the architecture of IMS-LD. Those recommendations are based on the constraints pointed out in Section 5. However, there is a need for presenting some further analysis, which can bridge both sections, from the constraints to the recommendations, since this in-between step is crucial to understand the rationale. We have organized the analysis as follows:

1. Analysis on general-purpose modelling. These elements will be used as part of others specifically implemented in learning processes, like personalisation. Furthermore, they become a basic set to be re-purposed in different contexts and goals. Therefore, this initial analysis comprises adaptive learning. A few very specific processes cannot be approached with just general structures. They need on-purpose elements which come across on-purpose goals on personalisation
2. Analysis on the integration of Units of Learning and a bi-directional communication with other external resources, systems and standards. When needed, we high-light the need for a way of communication (e.g., a communication layer) although its development is something outside of the scope of this research. We are focused on the specification itself and how to improve the pedagogical expressiveness, and not on building any ad hoc technical artefact to get this aim through.

Out of this analysis, we conclude that specific recommendations should be categorized in three groups:

Modelling, that compiles every single extension, modification or addition, general or specific, to the specification and the information model; and b) Architecture, that deals with functional requirements of the spec, with a focus on the interoperability, communication and integration of IMS-LD with other external means. In both cases, we look for the highest performance along with the minimal structural change. Furthermore, we respect the original specification as much as possible and try to make as few changes as possible; on the other side, they all are needed to build the suggested solution, and cope with the overall approach. In addition, c) we reflect some recommendations about the authoring tools. Although they are not responsibility of the specification, they are indeed related to IMS-LD, since the tools which allow the end users to create useful and applicable Units of Learning, can make the process easier or more difficult, and therefore it constraint the actual use and outcomes.

Furthermore, we depict our conclusions within the same two main blocks that we have used to carry out the analysis: modelling (with a special focus on adaptation) and integration. Out of our solution, we also provide a brief note about authoring tools.

Modelling and Adaptation

With regards to general modelling, and modelling focused on adaptive learning we conclude that IMS-LD shows a metaphor difficult to understand. It is not as much to say that people do not understand what a theatre is or how a play is performed. The key issue comes when a teacher needs to translate this well-known structure into specific pedagogical resources and features. This translation process turns not to be so obvious. The conceptual model is clear: play, acts, roles, role-parts, and so on. But all of them, interlaced in a whole structure of learning, become complex. Even the simplest scenario requires some knowledge of the specification in a technical way. And this is far from being user-friendly, moreover when the usual target people consists of non-technical profiles.

The notation itself follows a usual XML Schema and the definition of the several elements and components of the spec can turn too complex, even for skilled programmers. The description of activities, activity structures, environments, and et cetera, and the long cascade of relationships amongst them, makes a difficult-to-trace chain out of a simple scenario. Not to mention when several roles are involved, when some components of Level B are used or when adaptive processes are required. The programming structure is quite easy, but the combination of elements, components and metaphor, makes it hard difficult to implement.

The programming components provided by IMS-LD are quite simple (i.e., simple condition, based arithmetic, visualization of variables, visibility, DIV layers, and et-cetera). On the other side, their syntax is long, which hinders the rationale of the modelling process itself.

Communication, Interoperability, Integration of Units of Learning

We study three ways of communication: 1) simple link between parts, 2) embedded information packages with no information exchange, and 3) full communication of information packages, sharing variables and states. This third solution becomes the most effective one. It implies the development of a communication layer that deals with effective bi-directional exchange of data between information packages. Furthermore, this solution allows for the communication and sharing of services, along with variables, values and states, between IMS-LD and any outside counterpart, i.e., other specifications (e.g. SCORM), languages (i.e. PHP, Java, and Action Script), and LMSs (i.e. LAMS, Moodle,. LRN).

Should this exchange actually happens, it will encourage the re-use of information packages in different contexts, and the development of templates, fostering the re-purpose of Units of Learning within and amongst the several communities of practice (target groups) involved in IMS-LD, beyond the very only technical niche.

In the same line, exportation and importation of Units of Learning is not developed so far; neither does any connection with a database. Once more, no information exchange with other entities is possible so far.

The current two-step working process that makes two isolated parts out of design-time and run-time, makes IMS-LD to be compiled and not interpreted. This distinction stops an on-the-fly visualisation and modification of the learning design, which would improve the interactive personalisation of the learning process. This issue deals with how IMS-LD is interpreted by tools and engines developers and not with how the specification is actually designed.

Authoring

As aforementioned, this research and paper are focused on the specification itself and it does not deal with tools. However, authoring tools largely influence what can be modelled and how. Therefore, we point out a couple of key issues that could support the actual adoption of IMS-LD by the target groups:

1. There is a need for high-level visual authoring tools. Nowadays there are two types of tools: effective but too technical, even for technical profiles; and simple to understand but not powerful, since they usually deal with the very basic Level A. The creation of UoLs should be as far as possible from technical requirements or the underlying elements, components or structure. A more visual approach would encourage the understanding and use of IMS-LD in a broader sense by target groups. Technical low-level editors should live along with the visual high-level ones, though
2. Any authoring tool should allow for an integrated modelling, working with the manifest, the resources and the required external XHTML files with a common interface. It should dependencies and ease setting of properties. This is a hot challenge, not possible so far.

RECOMMENDATIONS: EXTENSIONS AND MODIFICATIONS

This section presents a rich and structured set of recommendations, modifications and extensions to improve the expressiveness of IMS Learning Design on adaptive learning processes. It lays on the aforementioned analysis. The following set of tables show a summary of the constraints, analysis, and recommendations (Table 2). The tables are structured as follows: in the grey-coloured, first row of each table, Column 1 (ID) numbers the constraints and analysis issues. Prefix M relates to issues concerning Modelling, and prefix A relates to issues concerning Architecture. Column 2 (Constraints.) provides a description of those issues numbered in Column 1. The white-coloured row(s) afterwards, presents the recommendation/s in the same couple format: ID and description.

Table 2. Constraints, analysis and recommendations

ID	*Constraints, analysis and recommendations*
(M.01)	Programming structures and resources are very basic (simple condition, simple arithmetic, properties set-up, visibility, DIV layers)
(Rec.01a)	Condition type case
(Rec.01b)	Condition type case with automatic ranges
(Rec.01c)	Conditional loop, type while
(Rec.01d)	Integer loop, type for-next
(Rec.01d)	Modification of the element <calculate>
(M.02)	There is no management of absolute time. There is no synchronization nor input point to work with relative time from
(Rec.02)	Modification of reference to relative time. Addition of reference to absolute time
(M.03)	Notification service, in Level C, is under-used. It only sends an email or plays an activity
(Rec.03)	Extension of the notification service, beyond using *sendmail* and playing an activity. It can be called from other structures besides the <on-completion> part of a learning activity
(M.04)	There is a blur way to handle the definition and use of properties and links amongst the several XML with global elements
(Rec.04)	Syntax modification, definition and use of elements view-property and set-property, as long as the properties which make use of them
(M.05)	Relationship between DIV layers and the visibility property is difficult to make and follow

Table 2. (Continued)

ID	*Constraints, analysis and recommendations*
(Rec.05)	In principle, the visibility property of any layer is turn off (hide), making simpler the conditional structure which could make use of it
(M.06)	There is no chance for iterations in any of the basic structures of the IMS-LD metaphor (learning activity, support activity, activity structure, act, play)
(Rec.06)	Extension of the current syntax of every element with a parameter <iteration> which defines a integer loop (type for-next) and-or a conditional loop (type while)
(M.07)	There is no synchronization input point in the manifest
(Rec.07)	Addition of an element GOTO which allows for a direct guiding of the learning flow
(M.08)	There is no chance to assign a specific activity to a selected user
(Rec.08a)	Addition of an element ASSIGN-ACTIVITY-TO-USER which allows for a direct match amongst users, groups and roles, with learning activities and activity structures
(Rec.08b)	Addition of an element ASSIGN-USER-TO-ACTIVITY which allows for a direct match amongst users, groups and roles, with learning activities and activity structures
(Rec.08c)	Addition of an element SWITCH-ACTIVITY which allows for turning on-off activities and activity structures
(M.09)	There is no chance to make groups out of a selection inside the instance
(Rec.09)	Addition of an element CREATE-GROUP which allows for grouping users of the same role
(M.10)	The monitoring service does not allow for monitoring of groups
(Rec.10)	Extension of the monitoring service to trace roles and groups
(A.11)	IMS-LD does not allow for saving or retrieving data in external files, of any kind of format. In addition, connections with external databases or modules developed with other languages are not described or supported within the specification
(Rec.11a)	Addition of the elements EXPORT and IMPORT to handle files with specific parameters (e.g., type TXT) and which is defined in a new property type FILE-IO
(Rec.11b)	Addition of the elements FROM-DB and TO-DB which allows for saving and retrieving data in a database of type MySQL. The connection is defined in a new property type DATABASE

(Continued)

Table 2. (Continued)

ID	*Constraints, analysis and recommendations*
(A.12)	There is no chance to modify the learning skeleton, method, roles definition or any other structural element in run-time
(Rec.12)	Addition of two couples of global elements: a) *view-IMS-LD* y *set-IMS-LD*, b) *view-resources* y *set-resources*, which allows for the visualisation and modification of the learning design and the related resources in run-time

At the project website pointed out in Section 3, every recommendation is expressed in an XML format, along with a full description, and one example. For instance (Figure 2):

```
                    <act        t e   c        t       >
                              <t   tle>          t    a   t       t  e act        t  <   t   tle>
                              <   te                      le     t   ue e     edeet t        >
                    <   act  t       e   c        t       >
                    <   te    at        >
                     <     >
                              <           e   te    e           e     >
                              <           e   talue>  <             e   ltue>    a
                     <       >
                    <      te    at        >
    <   lea              aet        t
```

```
    <calculate>
    <                                                >
           <          e   t    e   e               >
           <   ult      l>
           <        u u  t   tal    e               >
                     <          e   t e  e                       >
                     <   u >
                              <           e   talue>  <        e   t    alue>
                     <      u>
           <          u   u    t    tal>
           <   ult      l>
    <   calculate>
```

a

```
    <lea              act        t         le     t   uee       aectt         >
                     <t   tle>   ct      t  t ca        ut<   t  tle
```

Figure 2. Example snippets of two recommendations

CONCLUSIONS AND FURTHER WORK

This paper shows the background about IMS Learning Design and how to model adaptive learning with this specification. In addition, we provide a thorough analysis of a number of learning scenarios and a detailed list of issues to be modified and improved in the specification to better express adaptation. Based on these outcomes we provide recommendations, modifications and extensions to IMS Learning Design in order to improve its expressiveness of adaptive learning.

With these regards, Level A of IMS-LD provides the basic skeleton and a general framework to work with Units of Learning. It makes the 80% of the whole structure. Level C, and above all Level B provide both the spec with stronger and more versatile resources. These two upper levels are the actual responsible means to model some of the current learning and teaching challenges (i.e. active learning, collaborative learning, adaptive learning, runtime tracking).

Furthermore, we examine how to represent adaptive and adaptable Units of Learning with IMS Learning Design in order to model different types of Adaptation. Based on a literature study, a distinction is drawn between eight types of Adaptation that can be classified in two clusters: a) the main group, with interfaced-base, learning-flow and content-base; b) interactive problem solving support, adaptive information filtering, adaptive user grouping, adaptive evaluation, and changes on-the-fly. Out of this research and modelling efforts we derived a number of findings focused on the limitations that IMS-LD provides. These findings are mainly focused on adaptive learning process. However, since this topic cannot be isolated from the overall approach of the specifications, some of the limitations, and further recommendations, also address other topics, like interoperability, or even authoring tools.

Indeed, IMS-LD will benefit from a re-structure and modification of several elements focused on modelling and architecture. It will also improve the overall pedagogical expressiveness, along with specific features on adaptation of learning processes and integration with other specifications, LMSs, and learning resources. These are two main objectives of the specification: personalised learning and interoperability. At the same time, IMS-LD would increase its level of implementation in real settings and a wider support from Communities of Practice of end users if one or several high-level visual authoring tools are developed. Nevertheless, this issue is out of the scope of this research, and it deals with research groups and companies working on the adoption of IMS-LD.

ACKNOWLEDGMENTS

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REFERENCES/BIBLIOGRAPHY

Ahmad, A., Basir, O., & Has-sanein, K. (2004). Adaptive user interfaces for intelligent e-Learning: Issues and trends. *Proceedings of The Fourth International Conference on Electronic Business*, ICEB2004, Beijing.

Baeza-Yates, R., & Ribeiro-Nieto, B. (1999). *Modern information retrieval.* Boston, MA: Addison-Wesley.

Brusilovsky, P., & Miller, P. (2001). Course delivery systems for the Virtual University. In F. T. Tschang & T. Della Senta (Eds.), *Access to knowledge: New information technologies and the emergence of the virtual university* (pp. 167–206). Amsterdam, The Netherlands: Elsevier Science and International Association of Universities.

Burgos, D. (2008). *Extension of the IMS learning design specification based on adaptation and integration of units of learning* (Extensión de la especifi-cación IMS learning design desde la adaptación y la integración de unidades de aprendizaje). Doctoral the-sis. University Carlos III, Leganés, Madrid, Spain.

Burgos, D., & Griffiths, D. (2005). The UNFOLD Project. *Understanding and using learning design*. Retrieved from http://hdl.handle.net/1820/548

Burgos, D., & Specht, M. (2006). *Adaptive e-learning methods and IMS learning design. An integrated approach*, Proc. ICALT2006. Retrieved from http://www.ask.iti.gr/icalt/2006

Burgos, D., Tattersall, C., & Koper, R. (2007). How to represent adaptation in eLearning with IMS Learning Design. *Interactive Learning Environments*, *15*(2), 161–170.

Butz, M. V., Olivier, S., & Gérard, P. (2003). *Anticipatory behavior in adaptive learning systems: Foundations, theories, and systems*. Berlin, Germany: Springer Verlag.

Chin, D. (2001). Empirical evaluation of user models and user-adapted systems. *User Modeling and Us-er Adapted Interaction*, *11*, 181–194.

De Bra, P., Aroyo, L., & Cristea,. A. (2004). Adaptive web-based educational hypermedia. In M. Levene & A. Poulovassilis (Eds.), *Web dynamics*, *adaptive to change in content, size, topology and use* (pp. 387–410). Berlin, Gremany: Springer Verlag.

IMS. (2001). *IMS content packaging specification. Version 1.1.3*. Retrieved April 28, 2009 from http://www.imsglobal.org/learningdesign/index.cfm

IMS. (2003). IMS learning design. Version 1. Retrieved February 27th, 2004, from http://www.imsglobal.org/learningdesign/index.cfm

Koper, R., & Burgos, D. (2005). De-veloping advanced units of learning using IMS learning design level B. *International Journal on Advanced Technology for Learning*, *2*(4), 252–259.

Koper, R., & Tattersall, C. (2005). *Learning design: A handbook on modelling and delivering networked education and training*. Berlin Heidelberg: Springer.

Merceron, A., & Yacef, K. (2003). *A web-based tutoring tool with mining facilities to improve learning and teaching*. Proceedings of AIEd'2003. Sydney: IOS Press.

Moreno-Ger, P., Burgos, D., Sierra, J. L. & Fernández-Manjón, B. (2007). *An e-learning specification meets a game: Authoring and integration with IMS learning design and <e-Adventure>*. Pro-ceedings of ISAGA. 2nd International workshop on Electronic Games and Personalized eLearning Processes (EGAEL2007). July, 9th-13th, 2007, Nijmegen, The Netherlands.

Romero, C., Ventura, S., De Bra, P. D. & Castro, C. D. (2003). *Discovering prediction rules in AHA! courses*. Proceedings of 9th International User Modeling Conference (pp. 25–34).

Specht, M., & Burgos, D. (2006). *Implementing adaptive educational methods with IMS learning design*. Proceedings of adaptive hypermedia 2006, Dublin, Ireland.

Van Rosmalen, P., & Boticario, J. (2005). Using learning design to support design and runtime adaptation. In R. Koper & C. Tattersall (Eds.), *Learning design: A handbook on modeling and delivering networked education and training*. Heidelberg, Germany: Springer Verlag.

Vogten, H., Tattersall, C., Koper, R., van Rosmalen, P., Brouns, F., Sloep, P., … Martens, H. (2006). Designing a learning design engine as a collection of finite state machines. *International Journal on E-Learning*, *5*(4), 641–661.

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SECTION 3

TOOLS

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11. OPENGLM

Integrating Open Educational Resources in IMS Learning Design Authoring

INTRODUCTION

The Open Graphical Learning Modeller (OpenGLM) is a learning design authoring toolkit that supports the authoring of IMS Learning Design (LD) (IMS Global, 2003) units of learning. IMS LD is a complex specification that allows learning designers to define the flow of teaching and learning activities in a unit of learning along with required services and learning objects. A unit of learning described using IMS LD authoring software can subsequently be deployed and used over and over again in any IMS LD compliant learning environment.

The main goal of developing OpenGLM was to provide comprehensive and intuitive IMS LD modelling software, which reduces the complexity of the IMS LD specification to a degree where teaching practitioners are enabled to build IMS LD conformant units of learning. A subsidiary goal thus was to create translation mechanisms that interpret a graphical representation of a learning design and convert it to the required XML format as specified in the IMS LD information model. These goals were achieved by viewing the activities of learners and instructors as the modelling core around which to build other aspects covered by the IMS LD specification. The activities are graphically displayed and may be freely defined and arranged by the learning designer.

Using OpenGLM, teaching practitioners are enabled to intuitively create units of learning to be played in IMS LD enabled learning management systems. A new educational opportunity is created as the barrier for access is lowered, and thus the number of learning designers that produce IMS LD conformant units of learning may be increased; more units of learning may then be produced, exchanged, and evaluated as was one of the original goals of the IMS LD specification (Koper & Olivier, 2004). To support the reader in understanding of how typical course planning and learning activity management steps are supported during authoring in OpenGLM, Table 1 matches typical course planning steps to the corresponding IMS LD authoring steps in OpenGLM. The typical course planning steps were obtained in a study with teachers (Derntl, Neumann, Griffiths, & Oberhuemer, 2011, p. 19–23) and the top ten steps were used for constructing the table. More details on

M. Maina et al. (Eds.), The Art & Science of Learning Design, 157–168.

the concepts used in IMS LD and in OpenGLM are given in the subsequent sections of this Chapter.

The Chapter is structured as follows. We first outline the technical background and development history of OpenGLM. We then go on to describe how learning design concepts and processes are represented as features in the authoring tool, with a focus on integration of open educational resources in the designs. We describe how this facilitates sharing and reuse of resources and designed units of learning, and eventually review how the tool and its features were evaluated in several previous end-user evaluations.

Table 1. Relating typical course planning steps to authoring steps in OpenGLM

Course Planning Step	*OpenGLM Authoring Step*
Design/select materials	Learning object creation, import, and management
Define content-oriented course structure	Content structure is defined via activities
Learning outcome definition; needs analysis	Learning outcome definition is possible at the learning design and activity levels. Prerequisites can also be included. Needs analysis is performed outside of OpenGLM.
Design teaching method/learning activities/task	Define learning and support activities, create environments (learning objects and services), and assign roles to activities
Set up learning management system	Export IMS LD compliant package and create a run in IMS LD player
Define time structure of course	Not possible in terms of calendar dates. Time limits can be assigned to activities
Design assessment method/assessment resources	This is achieved as part of regular activities and learning environments in OpenGLM
Choose course topic(s)	Not applicable; outside OpenGLM
Look at course description in curriculum	Not applicable; outside OpenGLM
Provide administrative course data (institution's course data base etc.)	Not applicable; outside OpenGLM

DEVELOPMENT CONTEXT AND TECHNICAL BACKGROUND

OpenGLM was developed in the context of the ICOPER project[1]. It is open source software, available for download from SourceForge[2]. There are platform specific binaries available for Windows, Mac OS X, and Linux. It is a cross-platform Java application based on Graphical Learning Modeller (GLM; Neumann & Oberhuemer, 2009), which was developed on top of the Reload Learning Design Editor's Java code base in the EU project Prolix[3]. Reload LD Editor (Griffiths et al., 2007) was developed at the University of Bolton as part of a project that focused on the development of tools incorporating emerging learning technology interoperability specifications. OpenGLM thus builds on a stack of existing code developed in previous R&D projects. OpenGLM's main add-ons to the original GLM include enhancements for supporting communities of practice in sharing IMS LD units of learning along with standardised learning outcome definitions by providing built-in features for search, import from and export to a large online repository—the Open ICOPER Content Space (OICS).[4] The OICS is a repository for different types of educational resources containing about 80,000 openly accessible objects contributed by content providers from all over the world, including OU's OpenLearn, OER Commons, MIT OpenCourseWare, to name a few.

LEARNING DESIGN CONCEPTS AND FEATURES IN OPENGLM

OpenGLM supports IMS LD levels A and B. Level A provides the core elements of the specification allowing the definition of activity sequences and their learning environments. Level B adds the concepts of properties and conditions which are useful for modelling the input to and output of learning and support activities and controlling more complex activity flows using conditional expressions, respectively. Level C adds notifications, enabling to dynamically control the assignment of roles to activities based on events. Since most learning designs can be modelled with levels A and B, level C was not implemented in OpenGLM. Of course, supporting the authoring of level C elements can be added to OpenGLM without limiting the existing functionality. For the current version of OpenGLM, the main goal was to provide a visual modelling metaphor that hides the complex aspects of IMS LD. For instance, OpenGLM does not confront the user with IMS LD concepts like plays, acts, and properties. The OpenGLM main window is presented in Figure 1.

The main window is organised into three panes: The left navigation pane contains shortcuts to all OpenGLM features; the centre pane contains the actual content in the context of the selection in the left pane; and the right pane contains the modelling palette and a set of ready-to-reuse teaching methods. The right pane is only visible in the modelling mode (i.e. the orange-coloured part of the navigation pane).

OpenGLM's visual modelling metaphor for IMS LD was conceived as described in the remainder of this section, whereby initial appearances of terms referring to IMS LD elements are printed in italics.

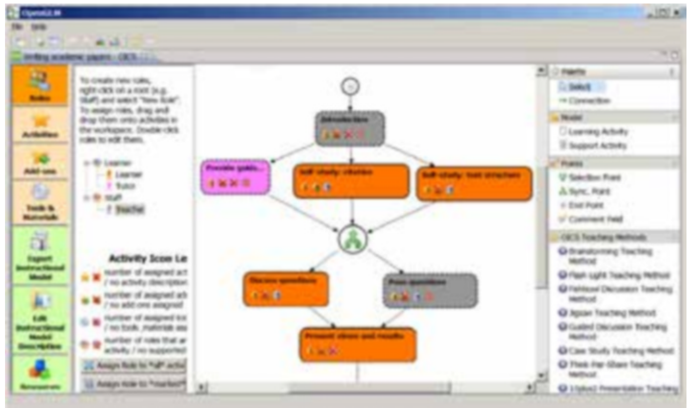

Figure 1. OpenGLM main screen

Learning and Support Activities

Activities are represented as rectangular symbols carrying the title of the activity and small icons referring to the activity's contents such as linked *activity descriptions*, *learning objects*, etc. The activity's fill colour reflects the colour of the role that is associated with it. This makes it easier for the designer not only to recognise at a glance which activities have roles assigned (this is a requirement of IMS LD), but also which particular roles are assigned. The colour code also facilitates a quick recognition of the overall distribution of roles over activities in the modelling workspace. A *learning activity* has a solid bounding box, while a *support activity* has a dashed bounding box.

Details of the activity can be edited by double clicking the activity symbol. In the edit dialogue (see Figure 2), it is possible to provide activity descriptions and other settings, as well as adding learning objects and *services* that are used by the activity. The terminology from the IMS LD specification was adapted for some of the concepts with more intuitive terms like add-ons, tools, and materials. The fact that IMS LD requires learning objects and services to be contained in *environments* is hidden from the user; the environment is created automatically (without any visual representation) when learning objects or services are added. Frequently used interactive activities like uploading files, writing a piece of text, etc., are offered without mentioning the *property* concept, which is used in IMS LD to capture role or person related data at runtime.

Learning objects can be added as *resources* either from the web via their hyperlink or as local, physical files. OpenGLM additionally allows the user to search for learning objects and other resources on the OICS and to add those resources to the *unit of learning* (see Figure 3).

Roles are represented as stick figures (see Figure 1); each role has a title and a colour, which can be defined by the modeller. Roles can be assigned to activities simply by dragging the stick figure and dropping it onto the activity symbol.

Figure 2. Learning activity editing dialogue

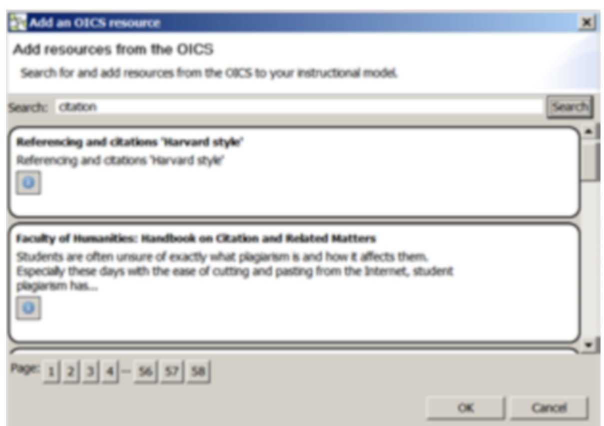

Figure 3. Adding a learning object from the Open ICOPER Content Space

Activity Flow

The flow of learning and support activities can be specified by connecting the activities with one of the routing symbols in the palette pane on the right-hand side (see Figure 1). This can be a connection (displayed as an arrow connecting the source activity with the target activity) as well as selection (fork), synchronisation (join), and end points. From the sequenced elements used in the unit of learning OpenGLM automatically creates the *play*, the required *acts*, and the *activity structures* for the forks and joins. However, these IMS LD elements are not presented to the learning designer in the user interface.

To facilitate the learning designer in building the unit of learning based on good-practice teaching methods, OpenGLM enables dragging one of the pre-defined teaching methods from the right pane (see Figure 1) and dropping it onto the modelling pane. These good-practice teaching methods are stored in the OICS in the form of IMS LD packages. Upon being dragged and dropped to the modelling pane, OpenGLM downloads the teaching method and places the contained activity sequence into the current unit of learning. The user can then adapt the pre-defined sequence and/or integrate it with the current set of activities.

Metadata and Learning Outcomes

Of course it is possible to edit the general descriptive metadata for the unit of learning, including the title, version, description, rights, prerequisites, learning outcomes, and other elements defined in IMS LD. However, OpenGLM goes one step further when it comes to defining the intended learning outcomes (see Figure 4; in IMS LD learning outcomes are called learning objectives) by providing the following features:

- Searching the OICS learning outcome repositories for existing learning outcome definitions, which can then be added as intended learning outcomes for the current unit of learning (see Figure 5).
- When the user creates a new learning outcome (see Figure 6), the newly created learning outcome definition is not only added to the current unit of learning as an intended outcome, it is also sent to a learning outcomes repository on the OICS, allowing it to be reused by other learning designers in other units of learning.
- While in IMS LD a learning objective can be provided as any kind of resource (e.g. plain text, binary document, etc.), OpenGLM adopted the IEEE Reusable Competency Definition (RCD) (IEEE, 2008) specification by describing each learning outcome with title, description, and type. This decision was made after a review of existing learning outcome specifications (Najjar & Klobucar, 2009) in the eContentplus project ICOPER, which supported the development of OpenGLM. Moreover, OpenGLM allows the learning designer to define for each learning outcome the proficiency level of the outcome according to the numeric scheme introduced by the European Qualification Framework for lifelong learning (EQF) (European Commission, 2008).

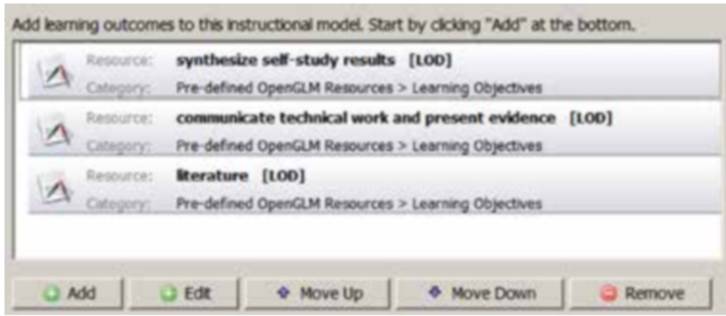

Figure 4. Overview of intended learning outcomes

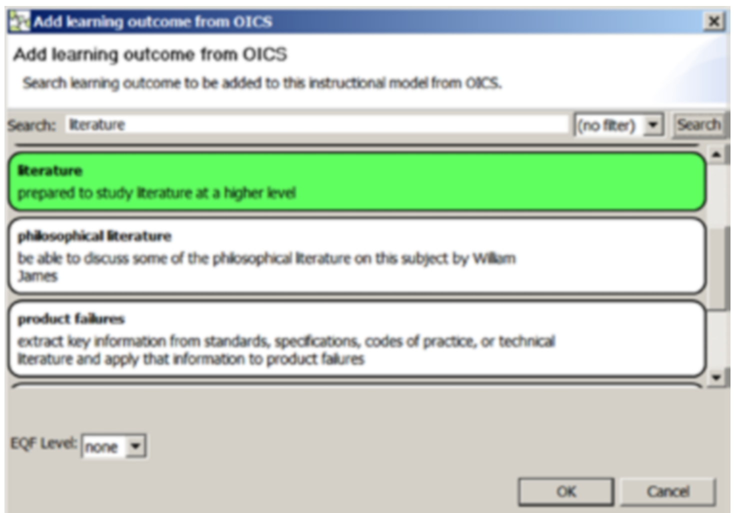

Figure 5. Searching for an existing learning outcome definition in the learning outcome repository

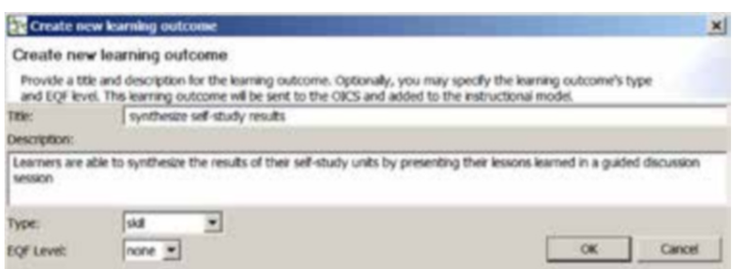

Figure 6. Defining a new intended learning outcome

Exporting Learning Designs

At any time, the learning designer may save the unit of learning and export it into an IMS LD compliant ZIP package. If there are any errors in the unit of learning (e.g. activities that are not connected to any other activity), OpenGLM will issue an error message with simple non-technical explanations.

If there are no errors, the unit of learning can be exported as an IMS LD package either on the local computer's hard drive, or to a remote unit of learning repository (see Figure 7). In the latter case, the unit of learning can be uploaded to any collection on the remote repository where the current user has write privileges. All other users with read privileges will subsequently be able to find and import this unit of learning into their own OpenGLM environment. By supporting this kind of online repository-based sharing, learning design communities of practice at individual and organisational level are provided with a powerful toolkit to manage their shared units of learning.

Figure 7. Exporting the unit of learning to the Open ICOPER Content Space

Searching and Importing

As mentioned earlier, OpenGLM offers features for searching in and importing from the remote unit of learning repository. The search dialogue window (see Figure 8) offers keyword based search in the full Learning Object Metadata (LOM; IEEE, 2002) record of the unit of learning. For instance, this can be used to search for units of learning that are licensed under a particular license, which is captured in the "Rights" category of the LOM standard. The search dialogue also allows to define special search filters so the keywords are matched in specific parts of the units of learning metadata, e.g. the intended learning outcomes, implemented teaching methods, or simply in the title and description. The units of learning that match the query are displayed in the result box. By clicking on the information icon, OpenGLM displays all information on the selected unit of learning, like full description, learning outcomes, end user language, licensing, and so forth. By clicking on the import button, the selected unit of learning is downloaded from the repository and visualised in the modelling pane. This feature enables learning design communities to build on each other's units of learning instead of starting from scratch every time.

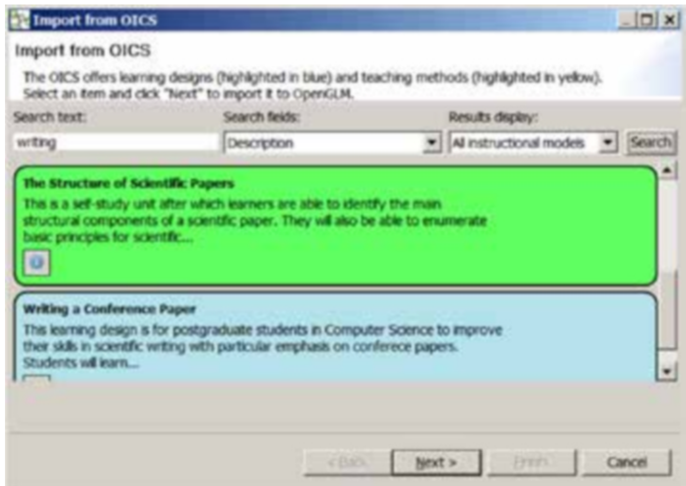

Figure 8. Searching and importing an existing unit of learning from the Open ICOPER Content Space

OPENGLM EVALUATIONS

OpenGLM and its predecessor GLM have been used by and for test-bed partners in large European projects. These include PROLIX, an integrated project in the Sixth Framework Programme on aligning professional learning with business processes and business requirements where GLM was initially developed. The OpenGLM add-ons were designed and implemented in the eContentplus project ICOPER, a best practice network on standards and specifications in learning outcome based education and educational content. These projects were the context for extensive evaluations of the authoring tool and its integration with educational practice.

To understand these evaluations, it is necessary to recall that OpenGLM was built on top of GLM, i.e. the visual IMS LD modelling metaphor was implemented in GLM, while the sharing use cases and the remote repository and metadata-related features were added in OpenGLM. Since the evaluations have been published previously elsewhere, in this Chapter we will provide an overview of the results and findings of these studies and point to the original papers for full details.

First studies evaluating GLM (Neumann & Oberhuemer, 2008; 2009) addressed different stakeholders of the tool including pedagogical experts, test-bed partners, IMS LD developers, and instructors as end-users. The studies revealed that the pedagogical experts without any knowledge of IMS LD were able to model given scenarios using OpenGLM; they were particularly fond of the drag and drop functionalities. The industrial test-bed partners in PROLIX evaluated the tool according to ISO standards for user dialogue principles. This evaluation produced mixed results, presumably due to an early incomplete version of the tool having been evaluated. IMS LD tool developers and experts had a highly positive opinion of the many aspects of IMS LD realization in GLM. GLM was also evaluated with a sample of 21 higher education instructors, who had to create units of learning using with the tool. While the instructors were generally successful in creating the units of learning, they had several suggestions for improvement, some of which were subsequently implemented, for instance the provision of templates or activity design patterns to reuse.

An end user evaluation focusing on opportunities and challenges of formal instructional modelling by example of OpenGLM was presented in Derntl, Neumann and Oberhuemer (2011b). The study used a given instructional design task structure for participants and then administered structured interviews with open-ended questions. The results revealed that users generally perceived a smooth authoring process in OpenGLM, however they did report some issues related to the terminology used in the tool, the reuse of existing resources and the integration with the Open ICOPER Content Space for import, export and reuse of teaching methods. In addition to these technical difficulties, users seem to have problems with the terminology used in OpenGLM, or with learning design concepts and terminology in general. The study also showed that participants were also questioning whether such formal design activities have any impact or relevance on their life as a teacher, since there is typically no appropriate reward by higher education institutions for spending effort on improving teaching.

The technical realization of standards-based sharing and reuse were discussed in detail in Derntl, Neumann and Oberhuemer (2011a), also focusing on the role of metadata and the key artefacts involved in such sharing processes. In this study several use cases and scenarios for communities of learning design practice are presented, such as searching for instructional models, annotating instructional models, and some learning outcome related scenarios. The study concludes that while such sharing scenarios are relevant to support teacher-designer communities, current academic practice is far from adoption, and that it would require commitment of practitioners and their institutions to move forward.

CONCLUSION

In this paper we introduced the Open Graphical Learning Modeller (OpenGLM), a learning design authoring tool that supports IMS LD levels A and B. OpenGLM intends to support the learning designer with an intuitive visual modelling metaphor that conceals the complex elements of IMS LD in the user interface, while still supporting these concepts “under the hood”. The tool is open source and available for all major operating systems.

One of the main advantages of OpenGLM is its support for communities of practice in the spirit of Web 2.0: the most important artefacts used and produced during unit of learning authoring can be searched, retrieved, and published in the Open ICOPER Content Space (OICS), an open, federated repository for educational resources. Collections within OICS can have a fine-grained hierarchy and privilege model, to support individual and organisational use cases.

The reviewed studies about the use of OpenGLM involving practitioners in real-world contexts reveal that these design-sharing tools do have a lot of potential in facilitating and improving the design process, and ultimately also the quality of teaching. However, it was also found that academic institutions and teaching practitioners are still reluctant to adopt such innovations and practices. Partially this is because the tools and processes are not mature enough yet, and not tailored to specific usage contexts and scenarios. Another reason that was identified is the general lack of a reward system in academic institutions for individuals who strive to propel excellence in teaching and learning design.

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NOTES

1. http://icoper.org
2. http://sourceforge.net/projects/openglm
3. http://prolix-project.eu
4. http://icoper.org/oics

REFERENCES

Derntl, M., Neumann, S., & Oberhuemer, P. (2011a). Community support for authoring, sharing, and reusing instructional models: The Open Graphical Learning Modeler (OpenGLM). Proceedings of IEEE ICALT 2011, Athens, Georgia, USA: IEEE.

Derntl, M., Neumann, S., & Oberhuemer, P. (2011b). Opportunities and challenges of formal instructional modeling for web-based learning. Proceedings of ICWL 2011, Hong Kong: Springer-Verlag.

Derntl, M., Neumann, S., Griffiths, D., & Oberhuemer, P. (2011). Report on usage of and recommendations for instructional modeling specifications. ICOPER Deliverable D3.2. Retrieved from http://is.gd/icoperd32

European Commission (Ed.) (2008). *The European qualifications framework for lifelong learning*. Retrieved from http://is.gd/eqf2008

Griffiths, D., Beauvoir, P., Baxendale, M., Hazlewood, P., & Oddie, A. (2007). *Development and evaluation of the reload learning design editor.* Paper presented at TENCompetence Open Workshop on Current research on IMS Learning Design and Lifelong Competence Development Infrastructures, June 21–22, Barcelona, Spain.

IEEE. (2002). IEEE standard for learning object metadata (1484.12.1-2002).

IEEE. (2008). IEEE standard for learning technology – Data model for reusable competency definitions (1484.20.1-2007).

IMS Global: IMS Learning Design Information Model. (2003). Retrieved from. http://is.gd/imsldspec

Koper, R., & Olivier, B. (2004). Representing the learning design of units of learning. *Educational Technology & Society, 7*(3), 97–111.

Najjar, J., & Klobucar, T. (Eds.). (2009). Report of the study of learning needs building blocks and the standards to be used. *ICOPER Deliverable D2.1*. Retrieved from http://icoper.org/deliverables/ICOPER_D2.1.pdf

Neumann, S., & Oberhuemer, P. (2008). *Supporting instructors in creating standard conformant learning designs: The graphical learning modeller*. In 20th World conference on educational multimedia, hypermedia & telecommunications, Vienna, Austria.

Neumann, S., & Oberhuemer, P. (2009). User evaluation of a graphical modeling tool for IMS learning design. In M. Spaniol, Q. Li, R. Klamma, & R. W. H. Lau (Eds.), Advances in Web Based Learning – ICWL 2009, 8th International Conference, Aachen, Germany, August 19–21. Proceedings. *Lecture Notes in Computer Science 5686* (pp. 287–296).

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12. REFLECTIONS ON DEVELOPING A TOOL FOR CREATING VISUAL REPRESENTATIONS OF LEARNING DESIGNS

Towards a Visual Language for Learning Designs

INTRODUCTION

CompendiumLD is a software tool for designing learning activities using a flexible visual interface. It has been developed as a tool to support lecturers, teachers and others involved in education to help them articulate their ideas and map out a design or learning sequence. This development has spanned 4 years, and the development process we have engaged in has served as a vehicle through which we have been able to better understand how educators relate to and use visual representations of learning designs.

In this chapter we describe how evidence gathered since CompendiumLD's first release has shown the many conditions in which it is likely to be applied and appreciated by users. Early staff surveys revealed a clear need for visualising learning designs with over half of the Open University staff who responded agreeing that it is becoming harder to understand how all the components of planned learning and teaching fit together. Furthermore, the use of technology is making the process of creating courses more complex. We explore these challenges and conclude with some reflections on the developments in visual representation needed to further facilitate the modelling of today and tomorrow's complex learning situations.

CompendiumLD comes with predefined sets of icons, some generic and some specific to learning design. The learning design icons enable the user to visually represent activity designs that concur with Beetham's definition of a learning activity: a specific interaction of learner(s) with other(s) using specific tools and resources, orientated towards specific outcomes.

These icons may be dragged and dropped, then connected to form a map that represents the interactions between tools, people, resources, outcomes and so on within a learning activity.

CompendiumLD is a specialised version of Compendium, a software tool for knowledge mapping, i.e. managing connections between information and ideas that has been applied in many domains including the mapping of debates, discussions

M. Maina et al. (Eds.), The Art & Science of Learning Design, 169–179.

and arguments. Compendium provides a default set of icons for creating maps to visualise the connections between ideas and information. Most of the core knowledge mapping facilities provided by Compendium are included within CompendiumLD. This means that users can use CompendiumLD for a variety of styles of learning design and apply it to other information mapping and modelling problems. Figure 1 shows three of the design views that CompendiumLD provides.

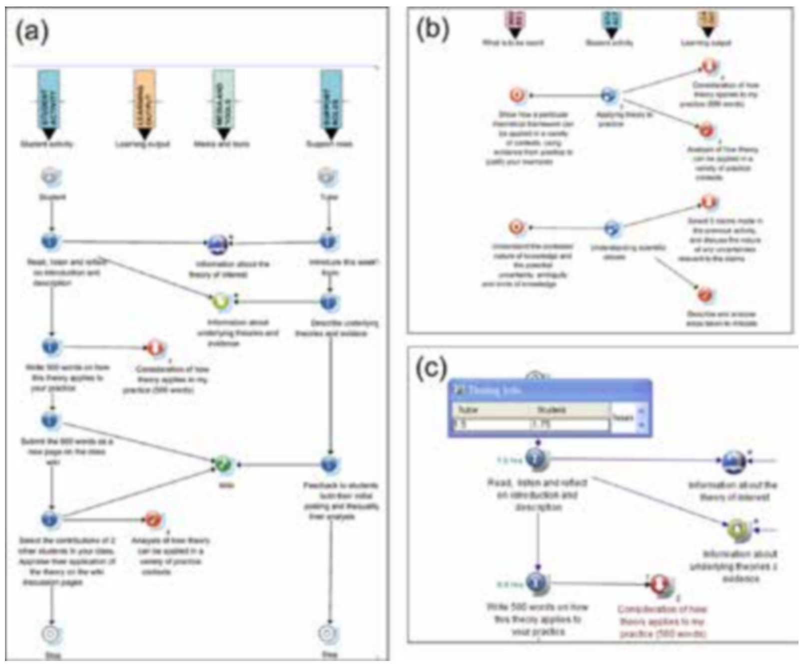

Figure 1. A variety of design representations created using CompendiumLD: (a) Learning sequence map (b) Learning outcomes view (c) Sequence map showing task times

CompendiumLD's development has occurred within the Open University Learning Design Initiative (OULDI), a project funded by the Open University and JISC.

RATIONALE FOR DEVELOPMENT

The decision to develop CompendiumLD was informed by claims that the advent of e-learning is making the process of creating course modules more complex, that staff are feeling more overwhelmed by the challenge of how to effectively integrate ICT in a course, and that staff find it is becoming harder to understand how all the parts or components of planned learning and teaching fit together. A survey of OU staff found over half agreed or agreed somewhat with these three claims (n=50). 47% of respondents were Teaching staff (as classified by primary role job titles such as lecturer), and 53% were Non-Teaching staff involved in production of teaching and learning materials (e.g. teaching and learning staff, media developers, managers, editors).

Compendium was selected as the basis for our tool as it offered significant and sophisticated functionality, which could be relatively easily adapted and modified for our purposes. The inherent philosophy underpinning Compendium, in terms of providing visual representation to support the development of thinking and shared argumentation also fitted our criteria for selection, as it aligned well with our requirement to develop a tool that would support user thinking specifically for the design process.

CompendiumLD was designed to allow users to model complex relationships between different aspects of a learning and teaching process, to do this in a relatively flexible and unconstrained way, and to allow individuals and teams to think ideas through before committing to implementation. The CompendiumLD concept is predicated on the belief that creating a visual representation of learning design can add value to the process of design and teaching. This is supported by studies of both experts and novices (albeit in fields other than learning design) showing that use of visual problem representations facilitates thinking and problem solving performance. It also builds on suggestions that the variation in degrees of success in problem solving (in this case, the solving of a learning design problem) among problem solvers might be attributed more to the meaningful representation of knowledge than to the amount of the designers prior knowledge.

At the time of CompendiumLD's initial development there were a variety of other learning design tools available for use and/or under development. For example, Phoebe aims to support users through a structured text based learning design process. Tools such as Reload enable users to create runnable learning designs by creating IMS-LD output. The London Pedagogy Planner aimed to support its users through making pedagogically informed design decisions through a variety of textual and visual representations. LAMS provided an interactive online environment for both designing and delivering online learning that is focused on collaborative learning activities. The purpose of CompendiumLD contrasts with these tools in that our aims was to provide a tool that would allow users to approach the design process irrespective of the pedagogy, technologies or structures to be used in the learning design (cf. LAMS), and that would provide an easy way into experimenting with design ideas through a focus on visual representation (cf. London Pedagogy Planner, Phoebe) at levels of abstraction chosen by the user. An intentional key difference between CompendiumLD and the IMS_LD based editors available at the time (cf. Reload) was the primary function of the software. The focus of IMS_LD based tools was on being able to run the designs, meaning users needed to make detailed design decisions necessary for executing the unit of learning in order to be compliant with IMS-LD. In contrast the intention was for CompendiumLD to allow a free form type of model development during which users could focus their attention on pedagogical design issues.

ITERATIVE DEVELOPMENT AND USE

Development

CompendiumLD has been developed iteratively since 2008, and 7 versions have been released since March 2009. Its initial development was informed by data on course design teams' practices collected at the Open University through interviews and observations during 2008 and 2009. This data showed that the learning design process is complex, creative and interactive one, and that even when collaborating within a team there is a large element of individuality within the process. Individual academics work at different levels of granularity and focus on different aspects of design over the curriculum design lifecycle, as do others in the design team e.g. software developers.

The earliest stage of prototyping involved adding some learning design icons to Compendium, without altering Compendium's functionality. The node-link form of representation provided by Compendium was (and is) considered useful for representing learning designs because of its flexibility. The ability to create complex networks of linked nodes meant that a great variety of arrangements and relationships between different concepts can be made; the user is not restricted to one particular form, e.g. a mind map emanating from one central node. The first version of CompendiumLD included a learning design icon set created by a graphic designer. Subsequent versions of CompendiumLD included refinements and additions to the initial icon set informed by the interview and observation data described above, consideration of Beetham's definition of a learning activity, heuristic exploration and application of Bertin's notions concerning visual variables such as size, shape and colour. This resulted in the CompendiumLD core learning design icon set, in which icons for related purposes share similar visual characteristics. The related purposes include the depiction of roles, actions (tasks and activities), tools and resources, student achievements, and process flow as shown in Figure 2.

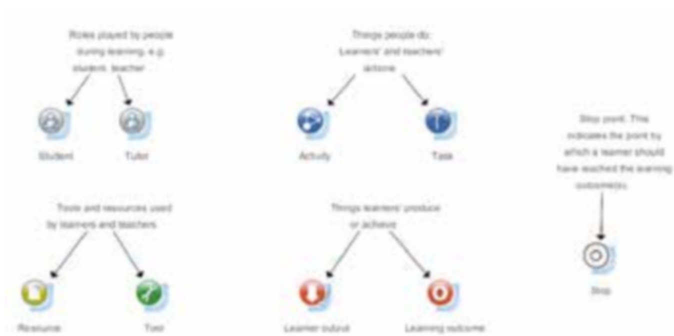

Figure2. CompendiumLD core learning design icon set showing icons showing icon groups related by purpose

These early versions of CompendiumLD also featured addition of functionality specific to learning design also informed by the interview and observation data described above. These include prompts, context sensitive help, and other learning design icon sets in addition to the core set shown in Figure 1.

Since CompendiumLD's first public release in March 2009 several types of developmental testing and evaluation have been carried out which have contributed to the focus and direction of development of the tool. Early testing and feedback was sought through surveys of media developers, editors and project managers (in March and June 2009), and evaluation by a novice user following a semi-structured script (in November 2009). Later, analysis of forum comments from students about their experience of use of CompendiumLD (2010 and later) were taken into account, and these were complemented by a less formal series of observations of use of CompendiumLD in workshops run by the OULDI team during the JISC project between 2008 and 2012. Overall, the testing and evaluation resulted in key changes to the tools functionality for saving and sharing learning designs, for copying, cutting and pasting design elements, to revisions and additions to the icon sets, and to the documentation and help resources provided.

For example, the survey of media developers, editors and project managers identified the main potential benefits were in supporting communication, creativity, clarification ('…of potential complex problems') and use in production processes and planning (such as future specifications, helping picture research, preparing drafts, and identifying gaps). As one participant said:

> I think that it would be useful for course teams to use devices like CompendiumLD when planning their courses. It would be good to have a visual representation of what the course was going to do, and how it was going to do it, at an early stage in course production. This would help to ensure that everyone involved was clear of the production plan, and would be able to understand their role accordingly.

This quote hints that one key perceived benefit of design visualisation in general or CompendiumLD in particular, could be to the overall design process (the communication of designs rather than sole use by a particular individual). Indeed, the last phase of our CompendiumLD development has focused on building functionality to embed SVG images (design maps) in to web pages to facilitate sharing.

Feedback and Use

CompendiumLD has been downloaded over 2,000 times since its release in 2008, and there have been several thousand visits to the online documentation, slide shows and screen casts provided to help users get started with the tool. For example, the 'getting started' screen cast has been viewed over 4000 times and downloaded 50 times since 2010 and two other presentations about CompendiumLD have been viewed more than 2000 times each. This indicates continued interest in the CompendiumLD tool.

The principle source of data about the user experience, however, is the evaluation undertaken for the JISC funded Open University Learning Design Initiative. The CompendiumLD tool and visualisation approach comprised one of range of tools and approaches trialled by the project over twelve pilots across six universities. The research used a mixed methods research approach that included post-pilot questionnaires (over 200 responses), stakeholder interviews, over 20 personal narratives and case studies, user testing, and field notes and reflective logs from over two dozen workshops. In particular, the personal narrative case studies reveal valuable insight in to individual and groups' reactions to using CompendiumLD and the visual representations created using it.

The benefit of having visual, rather than textual, representations was often noted by participants in the pilots and associated workshops. One participant from Brunel University noted

> this is a really good visualisation of a module. It's interesting to see this representation as opposed to the textual ones that we [usually] use.

The evidence indicates that CompendiumLD and the visual approach it represents may prove particularly useful support for those with some prior skills in visualisation. An academic from London South Bank University who was familiar with visualisation techniques

> picked up the concept and 'ran' with it… see[ing] the value in the methodology,

whilst an academic from Reading University, also familiar with visualisation in the form of concept, concurs and noted

> it makes you think about the different components of the learning process in a way that is structured, and it makes people address these issues and discuss them.'

Furthermore, also in the Reading pilot, a participant thought the

> 'thoroughness… was aided and abetted by the software process – the tool in use … -my view is that its revolutionised our thinking [about] learning and teaching,

and more broadly, it was noted that:

> CompendiumLD really helped with visualisation and making the process of curriculum design explicit, bringing sophistication to the course design practices already embedded in the School. (Papaefthimiou, 2012)

The concept mapping approach used by CompendiumLD was certainly appreciated by some users in helping them build understandings of relationships between module elements. As one user from the University of Hertfordshire explained:

> The mind-map structure is open and invites a creative response to the design, but some designers my find this lack of structure limiting. There are some stencils, or sample templates to use to guide the planning. The separate components of the design, tasks, resources etc, are indicated by icons that can be moved around the screen and linked together. This allows for easy exploration and revision of the design. The output is a mind-map of the design that is clearer and could be shared with colleagues for annotation and editing (Posting on Cloudworks, member of staff from University of Hertfordshire)

It was also useful to help understand the complexity of a design. As one participant from the Reading University pilot noted:

> [I got benefit from] visualising module or course design through CompendiumLD and' [there was a] very good focus for developing a complex case study based module using Compendium[LD] as a vehicle for refining design and delivering strategy'.

Many staff, however, faced challenges in both visualising a module and using computer software to undertake this visualisation, often because they were unfamiliar with the approach or lacked skills in using visualisation software (such as concept or mind mapping). Indeed, one participant interviewed after the Brunel University pilot explained:

> Staff have generally not visualised their designs in the past, apart from possibly flipchart or pencil and paper efforts at times (due to the traditional nature of face to face teaching). They were introduced to CompendiumLD for the first time. The opportunity to reflect on the design of their programmes, their personal design practice, and the range and balance of topics. were generally commended.

Feedback suggested that for some 'getting their head around' CompendiumLD, and the representations it enables users to create, can be a significant change and challenge. The fact that many staff did not appear to have or be keen to learn visual techniques to map, understand and design was a consistent observation across the pilots (Cross et al., 2012). Reservations included remarks that using CompendiumLD took too much effort, and that it would require formal training to achieve beneficial results.

Outside the OULDI project there are several other examples of use that we have become aware of. For example, CompendiumLD has been used in the Master of Science in Learning and Teaching Technologies course offered by the University of Geneva during 2012, 2011 and 2010. Examples of the activities that students have to undertake are available on the university's edutech wiki and designs produced by students of the course are also available via the same wiki[1]. A comment from a student at the University of Geneva shows that whilst initially, the 'blank canvas' of the mind map was daunting for some, this can be overcome:

> I met some difficulties in modelling the learning scenario in CompendiumLD: … what information must be presented on the map? [Then] I discovered the … sequence mapping icons. These are a great way to guide the implementation of the concept map! Finally, I realised that a concept map, well-built and well-reasoned a priori, [can be] used to implement the [LAMS] activity in a very easy way, (translated from the French original).

Other evidence of use outside the OULDI project includes the appearance online of Spanish translations of CompendiumLD documentation (e.g. http://www.slideshare.net/sirear/tutorial-compendio-ld, http://www.slideshare.net/sirear/nodos-e-iconos-de-compendiumld). Also, CompendiumLD was used for the design of Elluminate tutorials in the ATELIER-D project.

DISCUSSION

Whilst favourably received by many teaching and learning specialists, and those with a professional interest in teaching and learning, CompendiumLD has not yet achieve widespread use. It remains considered by many academic staff as a specialist design tool, or one that has yet to convince that the time investment required will yield return – put another way, that the problems or errors in a design that such visualisation can help reveal are not considered worth the additional effort by academic members of staff.

However, evidence gathered from users since CompendiumLD's first release in 2008 has suggested the conditions in which it is likely to be applied and appreciated by users. These can be summarised as characteristics of the problem to which it is applied, and the characteristics of the user(s) making use of it, i.e.

- users are comfortable with a visual approach
- the design problem features many design choices (e.g. a free choice of tools, resources, teaching approach etc.).

With respect to the former, one method to better engage those unfamiliar with visualisation was trialled during the second OULDI workshop at London Southbank University (LSBU). Here participants were asked to do the same visualisation task (build a sequence map) as at other workshops, but this time using paper with stickers of the CompendiumLD icons rather than using a computer running CompendiumLD. The LSBU report notes that

> most academics are less skilled in this area; for them sticking to paper-based tools in a face-to-face situation has proved a better option.

We have not yet tried this approach more generally, and other means of bridging the gap between paper and computer-based visualisations remain to be explored. The latter characteristic requires potential users to be able to identify appropriate design problems from within the mix of learning design problems they are faced with.

Whilst we did experiment with context-sensitive help for the design being worked on within CompendiumLD we have not yet provided any guidance for users to point them towards the type of problem that CompendiumLD has been seen to be of benefit for, so this remains on our 'to do' list. (We did not see Context-sensitive help as a priority because of an unenthusiastic response to initial prototypes, the need to focus developer resources, and the availability of Cloudworks as an alternative source of guidance). Given that staff are feeling more overwhelmed by the challenge of how to effectively integrate ICT in a course, and that they find it is becoming harder to understand how all the parts or components of planned learning and teaching fit together, we feel the role of visual representation as an aid to design is worth exploring further, be it through CompendiumLD or alternative routes. To that end, we put forward some ideas for visual developments the next section.

Looking to the Future - Some Ideas for Visual Developments

Earlier in this chapter we stated that we had considered Bertin's ideas about visual variables during the iterative development of CompendiumLD. Bertin drew on a background in cartography to develop his theories, and they have been widely applied to visualisation problems in many domains. We now consider whether Bertin's ideas could provide additional benefits in the application of visual representation to learning design.

The approach taken by Bertin is to consider the concepts to be represented (e.g. task, role, tool etc.), then to identify the dimensions of each concept that are important for the particular application, and to consider how each dimension is organised. Dimensions can be organised in 3 ways: they can be qualitative, ordered or quantitative. Occurrences of qualitative concepts are reorderable, i.e. there is no implicit ordinal relationship among them. For example in our CompendiumLD representations, we consider the tool concept within a learning activity to be a qualitative concept, and the 'levels' along the tool dimension are the available tool types (wiki, blog etc). These tool levels are represented by a textual label. We also represent the output that a learner produces as a qualitative variable, named in terms of the way that the output is assessed within the design (formative, summative etc.). To date we have used mainly the visual variable of colour to discriminate the component parts of a learning activity, whilst also indicating relationships in purpose, as shown in Figure 2. Indeed, in our current representation of a learning activity all of the concepts that make up an activity are qualitative, except the task concept. For a task or activity, there are two dimensions that are quantitative: its duration, and its position in a sequence. Ordered concepts are those that can be sorted in that they have 'greater than' and 'less than' relationships to each other, but do not have a numerical value. For example the descriptors 'small', 'medium' and 'large' are ordered. Could or should any of the other concepts in our learning design vocabulary be ordered, quantitative, or have other qualitative aspects represented visually, so as to help users design?

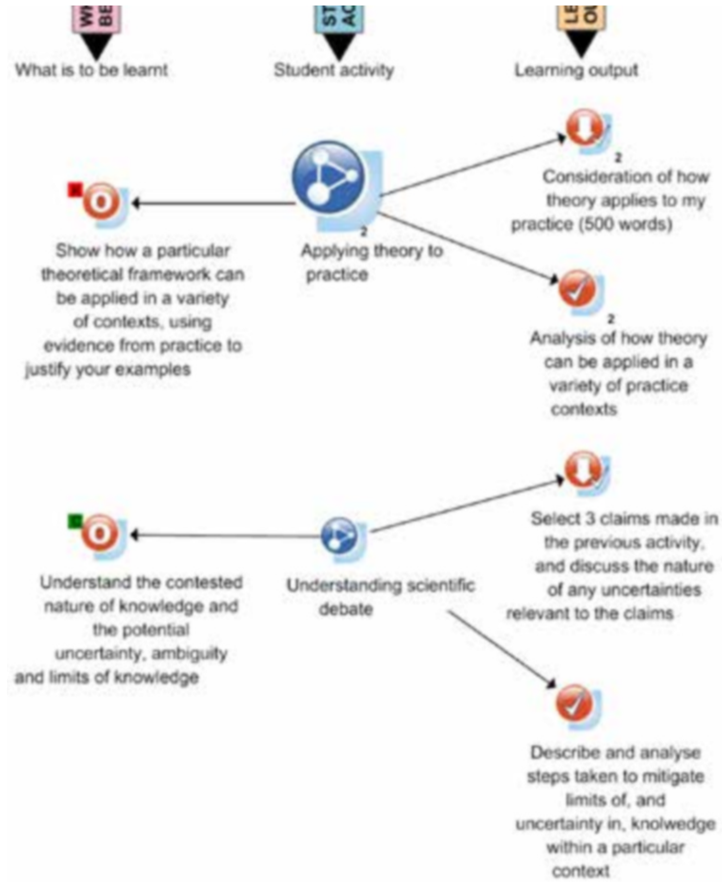

Figure 3: Learning outcomes view showing outcome types and activity durations

For example, to drive a design forward based on the nature of the intended outcomes, we could add dimensions to the representation of a learning outcome. Instead of the single learning outcome icon we currently use to represent any and every learning outcome, we could represent the type of learning outcome e.g. knowledge and understanding, cognitive skills, professional/practical skills, through addition of either a textual or coloured tag. An outcome classified in this way could be used by the software to facilitate steps in the design process as illustrated in the following scenario. When the designer comes to map out the detail of a learning activity that is intended to deliver a particular learning outcome they will have to make various decisions, including specifying the tasks and tools that learners will utilise to reach the outcome. For a learning outcome classified as (for example) a 'cognitive skills' outcome, the designer could begin by specifying a task. The software could prioritise tools which are known to be appropriate for developing these skills, with the prioritisation of tools being achieved through a cross-comparison of the vocabulary used to write outcomes with the key words used to describe the task for which tools are known to be useful for. Furthermore, colour coding of learning outcomes could enable the designer to see at a glance the make up of outcomes in our outcomes view. A further refinement would be to represent the intended learning effort (time spent) on the activities, e.g. by varying the size of the activity icons. An example of a learning outcomes view visualised using these ideas is shown in Figure 3. This figure shows a representation of two activities, of which the ‘Applying theory to practice’ activity is intended to occupy the student for double the duration of the other activity, hence the radius of the icon is double the size. One of the learning outcomes is a ‘cognitive’ outcome, which has a green flag showing a ‘C’ at its top left point. The other is a ‘knowledge and understanding’ outcome, which has a red flag with showing a ‘K’ at its top left point.

This representation should help the designer because it shows clearly how the learners’ effort relates to different types of outcome.

CONCLUSIONS

In this chapter we have reflected on the development of CompendiumLD, a tool for creating visual representations of learning designs. We have described the conditions in which CompendiumLD is likely to be applied and appreciated by users. These can be summarised as characteristics of the problem to which it is applied, and the characteristics of the user(s) making use of it, i.e.

- users are comfortable with a visual approach
- the design problem features many design choices (e.g. a free choice of tools, resources, teaching approach etc.).

We have discussed how Bertin’s ideas on the semiology of graphics can be used to advance the visual representation of learning designs, and have presented an initial experiment to illustrate the approach. Further experiments of this type will help us move towards a visual language for learning designs.

NOTE

1 This search produces examples of students’ work i.e. their ‘rapports’ https://www.google.com/search?hl=en&lr=&noj=1&biw=1024&bih=637&q=compendiumld+rapport+11+site%3Aunige.ch&oq=compendiumld+rapport+11+site%3Aunige.ch

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13. THE E-DESIGN TEMPLATE

A Pedagogic Guide for e-Learning Designers

INTRODUCTION

The e-Design Template is a Word-based pedagogic template that guides teachers when planning e-Learning. It highlights the core principles for effective e-Learning and invites users to focus on designing learning activities that embed these principles. The template suggests activities for a range of delivery patterns, including distance and blended learning. It can be used to design curriculum-focused or tool-focused e-Learning. It has been used successfully to design small courses, whole awards and to review existing e-Learning designs. In this chapter, the e-Design Template is described with detailed examples. The value of this approach for sharing and re-use within a broader, online community of practice is also discussed.

An emphasis on best practice principles is not always explicit in e-Learning models. Other similar e-learning tools and templates tend either to employ an approach based on a single learning theory, or fail to elaborate the theoretical model underpinning the framework at all. For example, the 3E Framework (Bruce, Smyth, Fotheringham, & Mainka, 2011) focuses on the practical implementation of e-learning encouraging student-centred learning and interaction without detailing the pedagogic principles underpinning the framework. Similarly, the exemplars produced by the AUTC project (AUTC, 2003) offer learning designs based on a range of pedagogic focuses, e.g. collaborative learning and problem-based learning without offering a rationale for these approaches.

Frameworks that are based on one or two learning theories include the Student-Owned Learning Engagement (SOLE) model (Atkinson, 2011) that is based on constructive alignment (Biggs, 2003) and Laurillard's conversational framework (Laurillard, 2002). In addition, the 5-Stage model (Salmon, 2004) is based on Social constructivist principles. Useful as these frameworks are, they nevertheless imply rather elucidate the full range of good practice principles for the novice designer.

More holistic learning design advice or guides, for example the 7 Principles applied to Technology (Chickering & Ehrmann, 1996), the Community of Inquiry model (Garrison, Anderson, & Archer, 2000) and the e-Learning Groups and Communities (McConnell, 2006) approaches are insufficiently detailed for a novice user to use in practice.

M. Maina et al. (Eds.), The Art & Science of Learning Design, 181–194.

Other approaches in this volume also allow novice designers to make design choices that would not be made by more experienced designers. For example, the ISIS Framework and the LdShake tools offer designers the opportunity to identify the pedagogic ‘intention’ but do not highlight best practice. OpenGLM allows the designer to apply a pre-defined teaching method and adapt it for their own design, but does not require this to be used. The CompendiumLD tool similarly, allows a free-reign of learning design.

The e-Design template aims to steer a way between holistic models and principle-light practical guides by offering a principle-based and practical-focused template to support best-practice e-learning designs.

Most online learning at Staffordshire University (UK) is developed by individual and small teams of teachers as there is no dedicated e-Learning development team to adapt and create e-Learning resources and activities. Guidance materials, support and a range of staff development courses and activities are available but teaching staff must design and develop their own resources and activities for online learning in what is essentially a ‘cottage’ style industry (Lentell, 2012). Learning design tools and technologies are often seen by university teachers as too complicated and taking too long to learn to use. In addition, tools that give a wide variety of choices and options make it difficult for teachers (who are subject specialists, not necessarily online pedagogy experts) to select the most appropriate tools, activities and structures. This sometimes means that the very tools designed to help teachers develop online learning become a barrier to that development.

The ‘e-Learning Models’ project was launched at Staffordshire University in May 2006 as one of a number of initiatives aimed at reducing some of the barriers to using technology in teaching and learning (Stiles & Yorke, 2006), as well trying to enhance the quality of e-Learning development at the University. Early objectives for the project included the development of representations or models of e-Learning illustrating good practice which could guide the adoption of e-Learning by novices and more experienced practitioners alike (Walmsley & Yorke, 2010). A set of models, frameworks, research articles and web-pages from a range of existing writers was gathered and made available in an online community of practice called the Best Practice Models for e-Learning Community. These resources were then used as the basis of a range of online and face-to-face community-based staff development activities to support the development of e-Learning design skills in participants.

A community survey in October 2009 produced a number of clear findings:

- linking the models closely to research outputs was important
- models were considered a useful guide to e-Learning design if they were based on ‘what works’
- members valued the ability to share their experiences of designing and using technology for teaching and learning, and

- members valued the opportunity to reflect on their use and learn from each other in a supportive community of practice.

A similar online workshop that focussed on learning designs for distance learning courses included a discussion between participants on the use of the models and user feedback included the following comments:

- I like the 'Best Practice Principles' slide for its readability
- The models are very useful!
- I think the models will be useful in pointing out different ways of doing things.
- Everyone is doing what they think is best without recourse to any unified model. I really like the e-distance model with all the helpful examples - a great start point.

To view the latest versions of the models, see the wiki here: http://learning.staffs.ac.uk/bestpracticemodels/

Following the survey and associated focus groups, it was decided to derive a set of principles for quality e-learning from existing models, resources and research, to create new Best Practice Models based on them. Links to research would be clarified and the focus would be on guiding e-Learning designers towards high quality e-Learning without merely listing all possible models and approaches. In addition, the new Principles and e-Design Template had to be flexible so that it would be easy to create new models for emerging technologies. From this, the new Principles and e-Design Template emerged and this has now been used successfully in a range of community activities and staff development sessions. The rest of this chapter describes the principles and some examples of e-Design Templates developed from them for different delivery patterns, pedagogic approaches and tools.

E-DESIGN TEMPLATE PRINCIPLES

It was felt that a number of existing e-Learning activities developed by staff were limited in scope and based on a largely transmissive theory of learning, despite the variety of pedagogic approaches being used by the same teachers in face-to-face activities. For example, many of our teachers used Blackboard (our institutional VLE) simply as a repository for course documents. Recent educational research supports constructivist theories of learning which propose that learning takes place through student activity, interaction with others and by students constructing their own learning. In their preface, Jonassen and Land say of these contemporary learning theories,

> At no time in the history of learning psychology has there been so much fundamental agreement about the epistemology, ontology, and phenomenology of learning. (Jonassen & Land, 2000)

The e-Design Template aimed to highlight and embed constructivist theories of learning, as well as other widely accepted principles of good learning including the

'Seven Principles' (Chickering & Ehrmann, 1996) as a trigger for developers when considering online activities. The e-Design Principles are:

- e-Learning is designed in timed chunks that emphasise time on task and expectations (Chickering & Ehrmann, 1996; GagnÉ, Briggs, & Wager, 1992; Means, Toyama, Murphy, Bakia, & Jones, 2010)
- e-Learning is assessed using a range of types (self/peer/tutor), options and choices (Carroll & Appleton, 2008; Irwin, 2007; Nicol, 2009, 2010; University of Hertfordshire, 2011; Waterfield & West, 2006)
- e-Learning includes a variety of interactions between students, teachers, peers and externals (Anderson, 2003; Laurillard, 2002)
- e-Learning is accessible, activity-led, collaborative and designed in phases that support, scaffold and increase learner independence (Gokhale, 1995; Johnson, Johnson, & Smith, 2007; Jonassen, Howland, Moore, & Marra, 2003; Race, 2010; Salmon, 2004; Schank, 2002; Stephenson & Coomey, 2001; Swan, 2005)

Space does not permit a detailed rationale for each of the principles above, however I will describe in more detail the 'phases' approach, as this has become a unique and important feature of the e-Design Template.

e-Learning offers the opportunity for a wider range of learning activities that can empower students to manage their own learning, but this opportunity is not currently widely exploited (Conole, 2010; Stephenson, 2001). The four phases approach in the e-Design Template scaffolds the learning designer as they build learning activities that gradually develop the learner's skills and confidence as self-organised learners.

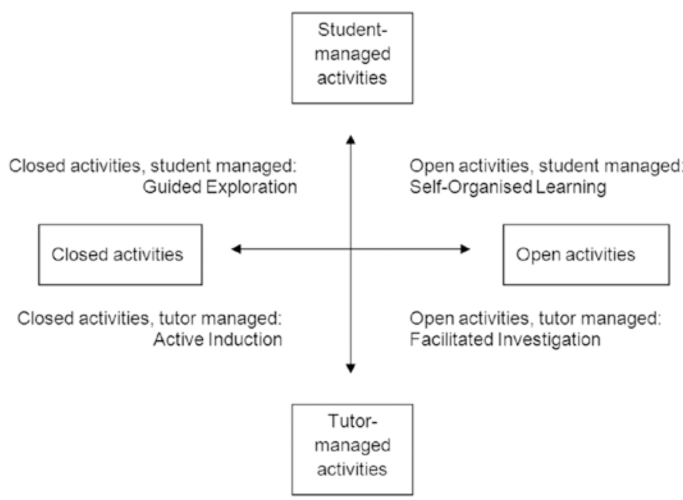

Figure 1. Four types of learning activity adapted from Stephenson and Coomey (Stephenson & Coomey, 2001)

The four phases approach was developed from Stephenson and Coomey who describe learning activities in two dimensions (Stephenson & Coomey, 2001). The first dimension considers the extent to which the task or activity is open or closed (e.g. is the answer to the question/task a single right or wrong answer, or is it open-ended?) The second dimension is concerned with the consideration of management and control (e.g., does the tutor dictate the task and method, or does the student have a choice?) This can be represented as four 'quadrants'.

Mirroring good practice in face-to-face teaching that leads students to autonomy (Elton, 1988), the quadrants can be used to guide the design of activities that are initially closed/tutor-managed, through closed/student-managed to open/tutor-managed and finally to open/student-managed. These phases have been named 'Active Induction', 'Guided Exploration', 'Facilitated Investigation' and 'Self-Organised Learning'. This offers a simple way for teachers to create scaffolded activities that support students as they develop their skills and grow in confidence as independent online learners. In the same way, assessment and interaction types can be varied, and new options offered as students move through the phases and widen their repertoire of online learning techniques. The principles are presented to teachers as a guide, but they are encouraged to use all the principles when designing their online learning activities. This approach could be considered rather more prescriptive than other learning design tools that offer a wider range of options. It is our experience, however, that by initially limiting the range of options and providing a clear structure to the template, teachers are enabled to design e-Learning easily, and to build confidence more quickly.

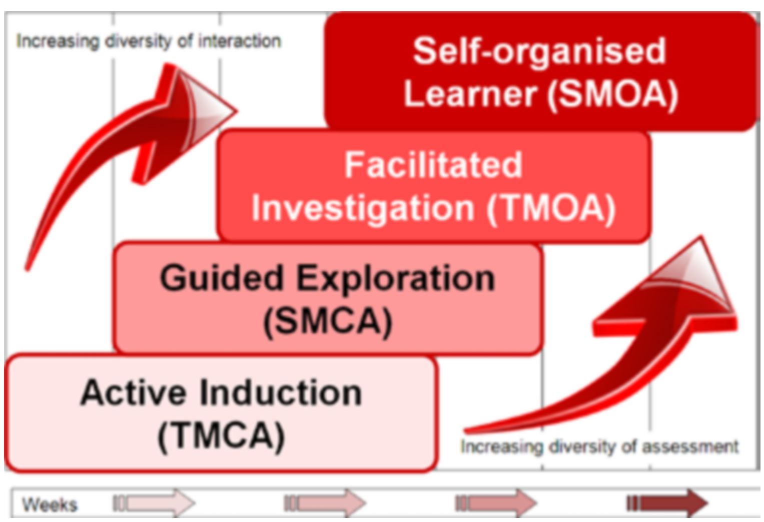

Figure 2. An illustration of the Best Practice Principles for e-Learning

The principles are used together with the e-Design Template as a guide when teachers are planning online learning activities. The e-Design Template includes a range of suggested activities mapped to the principles. These activities are derived from case studies, experience and the contributions of the Best Practice Community. The activities are described using simple language that concretely summarises the learning task or activity. The learning activity language is loosely adapted from the language used on the Ulster Hybrid Model (University of Ulster, 2008).

The principles are intended to support the pedagogic planning of online learning activities and it is assumed that many other considerations of effective learning are being considered, for example, the seven principles as above, alignment of learning outcomes and activities, appropriate learning aims and objectives, and so on. The e-Design Template becomes a representation of learning that the teacher uses as the basis for building online learning activities, for example, distance learning activities. The e-Design Template is intended to be a user-friendly learning design representation that uses the teacher's own language. The representation of learning designs for use and sharing is problematical, as many teachers use a variety of mental models of learning and so tend to prefer a variety of representations. The MoD4L project investigated issues of sharing and re-use of learning designs and found that,

> An effective representation for sharing and reuse has not, so far, been developed, even in Further Education where sharing and reuse are institutional norms. (Falconer, Beetham, Oliver, Lockyer, & Littlejohn, 2007)

A number of e-Design Templates have been developed that give examples of the types of activities that follow the principles and can act as a 'prompt'. The e-Design Template is scalable and can be used to design an award, module or lesson. Templates have been designed for a variety of delivery patterns, tools, pedagogic approaches and discipline subjects. Examples of e-Design Templates for distance learning and web-conferencing are given below.

DELIVERY PATTERNS

e-Design Templates have been developed for a selection of online delivery patterns to suit a range of delivery styles, cohort structures and pedagogic approaches and include, for example:

- *e-Supported:* in this pattern, all teaching is face-to-face, but students have access to a wide range of resources and informal learning opportunities online.
- *Blended Learning (Integrated):* this includes online activities to prepare for and reflect on classroom sessions. Each teaching and learning session is planned with three integral parts: (1) an online preparation, (2) the face-to-face and (3) online reflection, follow-up, assessment etc.
- *Blended Learning (Concentrated):* this includes online activities that are in chunks or blocks, for example during the summer for accelerated programmes.

The online activities may be a continuation of face-to-face study or may be separate and self-contained

- *Distance Learning (Discussion-based):* this includes activities built around online discussions with peers and/or work/placement colleagues.
- *Distance Learning (Collaborative-based):* this includes online activities designed to encourage collaborative group work with peers and/or work/placement colleagues.
- *Distance Learning (Individual):* this includes online activities designed to encourage active learning, self-organised learning and independent study. These may be run in a cohort pattern (with groups starting at set dates), or with roll-on-roll-off ongoing enrolment.

The suggested learning activities are expressed in simple language that describes the essence of each activity and includes those that are in common use as well as suggestions that are more innovative. The range of activities is intended to reflect the principles, and activities are designed for each of the four phases. For example, Table 2 is an illustration of an e-Design Template for distance learning (discussion-based) and includes a range of activity suggestions:

Table 1. e-Design Template for distance learning (discussion-based)

Active Induction (TMCA)	*Guided Exploration (SMCA)*	*Facilitated Investigation (TMOA)*	*Self-organised Learner (SMOA)*
Students post responses to tutor-set questions in forum	Students read peer responses and add comments/ suggestions	Students challenge and build on another's ideas	Students summarise and reflect on discussion. Students 'braid' discussion and create new resource to share
Delphi: Students post a question	Delphi: Students answer another student's question	Delphi: Students add a comment to a student's answer	Delphi: Students review and reflect on questions, responses and comments
Debate: Students read stimulus material and post individual statement	Debate: Students work in groups to agree and post a supporting or opposing argument	Debate: Students post responses to arguments	Debate: Students vote and review conclusions
Role-play: Students read stimulus materials for situation/ problem	Role-play: Students assigned roles and review context and problem	Role-play: Students post responses to situation/ problem	Role-play: Students contribute final conclusion. Students review roles and conclusions

E-LEARNING TOOLS

The e-Design Template can be used to illustrate suggested activities that map to the principles for a particular tool or technology, for example: e-portfolios; blogs; social bookmarking; electronic voting systems; mind maps and so on. New templates are simple to set up for emerging technologies. An example of how the e-Design Template can be used for web-conferencing is given below, together with suggested student activities:

Table 2. e-Design Template for Web-conferencing

Active Induction (TMCA)	*Guided Exploration (SMCA)*	*Facilitated Investigation (TMOA)*	*Self-organised Learner (SMOA)*
Students join online web-conference and introduce themselves to room in chat	Listen to tutor/ expert presentations and add comments/ questions in chat	Student groups/ pairs deliver presentation as part of whole web-conference	Students present own/group research or project outcomes in web-conference
Tutor invites opinions using polls tools, questions and comments	Listen to series of linked presentations by different presenters followed by Q+A	Students prepare questions for presenter and lead topic discussion on audio or in chat	Students host web-conference with expert for group
Students participate in icebreaker activity	Respond to tutor's questions with audio or chat	Nominated student leads a discussion	Expert is invited and interviewed
Participate in online familiarisation with interface	Students add annotations to whiteboard	Students prepare PPT/ links to share as part of plenary	Students use web-conference room to collaborate during preparation work of group projects

USING THE TEMPLATE TO PLAN E-LEARNING

The e-Design Principles and Template have been used in a variety of face-to-face and online workshops to stimulate discussions with teachers about the kinds of activities that can be included in online settings. In our experience, novices tend to begin by designing transmissive online learning using a bank of resources and independent study, despite most teachers using problem-based or discussion-based learning in face-to-face settings. The use of the template encourages teachers to 'fill in the blanks,' that is to consider a wider range of activities, interactions, assessment types, and to think about how to adapt

e-Design Tool Template for:

Principles	Active Induction (TMCA)		Guided Exploration (SMCA)		Facilitated Investigation (TMOA)		Self-organised Learner (SMOA)	
1. Add 4-8 activities (one/two for each phase) that students can do with this tool.								
2. How long will this activity take?								
3. Who will the students be interacting with?								
4. How will this activity be assessed?								

Figure 3. Blank e-Design Template used in staff development workshops

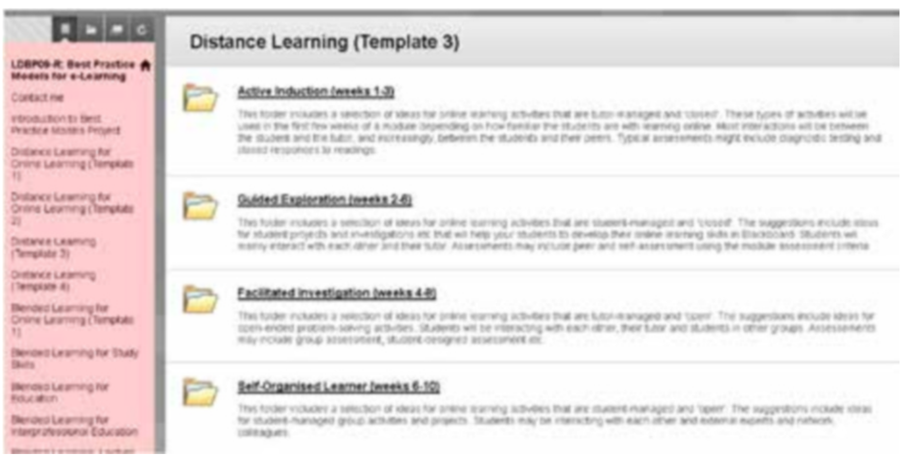

Figure 4. Blackboard structure with the phases and guidance

activities for each of the 'phases'. This has the effect of 'scaffolding' teachers' design activities. An example of the blank version of the template used is given in Figure 3.

Once the teacher has an overall mental construct of the learning activities, the course structure and content can be developed using the appropriate delivery tool (e.g. Blackboard). For example, the e-Design Template was used at Staffordshire University to create a set of online learning activities to develop undergraduate study skills. As an additional scaffold for the teacher, a Blackboard (Virtual Learning Environment) presence was populated with the four phases and with specific guidance for generating an online learning course. Figure 4 shows the template and guidance in Blackboard.

The materials were then developed by the Study Skills team to share with subject teachers and were made available with some of the e-Design Template guidance to support adaptation and re-use. Figure 5 is a screenshot of the completed Study Skills online activities in Blackboard

Figure 5. Completed Study Skills materials in Blackboard

In another example, the e-Design Template was used by a tutor to plan online activities for a Coaching and Mentoring distance learning module. Each two week block of study included a range of activities that were mapped to the principles and phases. The tutor commented that this was a quick way to build a set of distance learning activities, and that his confidence grew as activities were added. Figure 6 illustrates some of the completed activities.

BEST PRACTICE MODELS FOR E-LEARNING COMMUNITY

The e-Design Principles and the resulting e-Design Templates for delivery patterns and tools have been shared with the Best Practice Models for e-Learning online community. Suggestions, comments and additional activity ideas have been incorporated into the ongoing development of the models. Additional activities

Figure 6. Completed distance learning activities for a Coaching and Mentoring Module

suggested during workshop sessions are added to the relevant template for use by the community. For example, an online workshop called: 'Using Twitter for Teaching and Learning' was designed using the e-Design Template and included an activity on using the principles to design learning activities using Twitter. In addition, one of the online activities invited participants to design their own learning activities that mapped to the model to share. Figure 7 is an illustration of the first few workshop activities on the course page in Moodle.

Figure 7. Example of workshop planned using e-Design Template

The suggestions for Twitter activities that were devised by participants during the workshop included a wide variety of innovative and creative learning activities, and a selection are included below:

Table 3. Selected learning activities for Twitter contributed during workshop

Active Induction (TMCA)	*Guided Exploration (SMCA)*	*Facilitated Investigation (TMOA)*	*Self-organised Learner (SMOA)*
1. Students invent words and definitions beginning with twitt. and tweet 2. Students use hashtag to sort relevant tweets 3. Send several tweets about yourself to create a stream that others can see to get to know you 4. Tweet one thing which is going well in your organisation & one thing which you are keen to improve.	1. Students access case study and tweet questions/ comments 2. Students use range of tools with Twitter 3. Complete a twitter circle 4. Follow famous tweeters 5. Students decide on project topic and tweet to tutor 6. Tweet a URL that references a point or supports an idea	1. Students tweet summary of learning 2. Students share updates and further resources to peers 3. Students deliver project presentation and audience tweets questions, comments, feedback 4. Tutor follows Student tweets on laptop while teaching	1. Students tweet evaluations of learning programme 2. Students tweet reflections on their learning – project topic and ILT skills 3. Students choose whether to continue Twitter group for peer support, learning and social networking 4. Students to summarise key points from a group's tweets

CONCLUSION

The e-Design Principles and the e-Design Template have been developed from a range of pedagogic research on e-learning, and have been supplemented in conjunction with a community of practice. It is a pedagogical guide to designing e-learning that can be used by both novice developers and experts alike, as well as by those reviewing their e-learning designs. The e-Design Template has proven to be easy to use, and simple to adapt for a variety of delivery patterns, tools and contexts. It is related to other learning design tools, but in addition, scaffolds the learning design process itself to guide teachers towards designing online learning activities that are carefully timed, include a range of interactions, scaffolded in four phases and aim to develop effective independent online learners.

REFERENCES

Anderson, T. (2003). Getting the mix right again: An updated and theoretical rationale for interaction. *The International Review of Research in Open and Distance Learning*, *4*(2).

Atkinson, S. (2011). Embodied and embedded theory in practice: The student-owned learning-engagement (SOLE) model. *International Review of Research in Open and Distance Learning*, *12*(2).

AUTC. (2003). *Learning designs* [Online]. Retrieved June 11, 2013 from http://www.learningdesigns.uow.edu.au/

Biggs, J. B. (2003). *Teaching for quality learning at university: What the student does*. Buckingham: Society for Research into Higher Education.

Bruce, S., Smyth, K., Fotheringham, J., & Mainka, C. (2011). *University benchmark for the use of technology in modules* [Online]. Retrieved June 11, 2013, from http://staff.napier.ac.uk/services/vice-principal-academic/academic/TEL/TechBenchmark/Pages/home.aspx

Carroll, J., & Appleton, J. (2008). *The 2008 plagiarism landscape*. [Online]. Retrieved September 13, 2011, from http://www.plagiarismadvice.org/documents/briefingpaper/

Chickering, A. W., & Ehrmann, S. C. (1996). *Implementing the seven principles: Technology as lever* [Online]. Retrieved June 4, 2013 from http://www.tltgroup.org/programs/seven.html

Conole, G. (2010). Bridging the gap between policy and practice: A framework for technological intervention. *Journal of e-Learning and Knowledge Society*, *6*(1), 13–27.

Elton, L. (1988). Conditions for learner autonomy at a distance. *Innovations in Education & Training International*, *25*(3), 216–224.

Falconer, I., Beetham, H., Oliver, R., Lockyer, L., & Littlejohn, A. (2007). *Mod4L Final report: Representing learning designs* [Online]. JISC. Retrieved December 20, 2012, from http://www.jisc.ac.uk/media/documents/programmes/elearningpedagogy/mod4lreportfinal.pdf

GagnÉ, R. M., Briggs, L. J., & Wager, W. W. (1992). *Principles of instructional design* (4th ed.). Fort Worth, TX: Harcourt Brace Jovanovich.

Garrison, D. R., Anderson, T., & Archer, W. (2000). Critical inquiry in a text-based environment: Computer conferencing in higher education. *Internet in Higher Education*, *2*(2), 87–105. Retrieved from http://auspace.athabascau.ca:8080/dspace/handle/2149/739

Gokhale, A. A. (1995). Collaborative learning enhances critical thinking. *Journal of Technology Education*, *7*(1).

Irwin, B. (2007). *Flexible online assessment*. [Online]. Retrieved August 2, 2011, from http://www.education.ed.ac.uk/e-learning/gallery/irwin_flexible_oa.pdf

Johnson, D. W., Johnson, R. T., & Smith, K. (2007). The state of cooperative learning in postsecondary and professional settings. *Educational Psychology Review*, *19*(1), 15–29.

Jonassen, D. H., & Land, S. M. (Eds.). (2000). *Theoretical foundations of learning environments*. Mahwah: L. Erlbaum Associates.

Jonassen, D. H., Howland, J. L., Moore, J. L., & Marra, R. M. (2003). *Learning to solve problems with technology: A constructivist perspective* (2nd ed.). Upper Saddle River: Merrill.

Laurillard, D. (2002). *Rethinking university teaching: A conversational frame work for the effective use of educational technology* (2nd ed.). London, UK: Routledge.

Lentell, H. (2012). Distance learning in British universities: Is it possible? Open Learning: *The Journal of Open, Distance and e-Learning*, *27*(1), 23–36.

McConnell, D. (2006). *E-learning groups and communities*. Maidenhead: Open University Press.

Means, B., Toyama, Y., Murphy, R., Bakia, M., & Jones, K. (2010). *Evaluation of evidence-based practices in online learning: A meta-analysis and review of online learning studies*. U.S. Department of Education.

Nicol, D. J. (2009). Assessment for learner self-regulation: Enhancing achievement in the first year using learning technologies. *Assessment & Evaluation in Higher Education*, *34*(3), 335–352.

Nicol, D. J. (2010). *The foundation for graduate attributes: Developing self-regulation through self and peer-assessment*. QAA.

Race, P. (2010). *Making learning happen: A guide for post-compulsory education* (2nd ed.). London, UK: Sage Publications Ltd.

Salmon, G. (2004). *E-moderating: The key to online teaching and learning*. London, UK: Routledge.
Schank, R. C. (2002). *Designing world class e-learning: How IBM, GE, Harvard Business School, and Columbia University are succeeding at e-learning*. New York, NY: McGraw-Hill.
Stephenson, J. (2001). Learner-managed learning - an emerging pedagogy for learning online. In J. Stephenson (Ed.), *Teaching and learning online: New pedagogies for new technologies* (Creating success). London, UK: Kogan Page.
Stephenson, J., & Coomey, M. (2001). Online Learning: It is all about dialogue, involvement, support and control – According to the research. In J. Stephenson (Ed.), *Teaching and learning online: New pedagogies for new technologies* (Creating success). London, UK: Kogan Page.
Stiles, M. J., & Yorke, J. (2006). Technology supported learning – Tensions between innovation, and control and organisational and professional cultures. *Journal of Organisational Transformation and Social Change*, *3*(3), 251–267.
Swan, K. (2005). A constructivist model for thinking about learning online. In J. Bourne & J. C. Moore (Eds.), *Elements of quality online education: Engaging communities. The sloan consortium*.
University of Hertfordshire. (2011). *ESCAPE - Assessment timelines*. [Online]. Retrieved September 13, 2011, from http://jiscdesignstudio.pbworks.com/w/page/30631817/ESCAPE – Assessment timelines – Assessment timelines
University of Ulster. (2008). *Hybrid learning model* [Online]. Retrieved December 14, 2012 from http://cetl.ulster.ac.uk/elearning/hlm.php
Walmsley, H., & Yorke, J. (2010). eLearning Models: a Web 2.0 approach to staff development in Higher Education. In D. Parkes, L. Hart, & G. Walton (Eds.), *Web 2.0 and libraries: Impacts, technologies and trends*. Oxford: Chandos Publishing Ltd.
Waterfield, J., & West, B. (2006). *Inclusive assessment in higher education: A resource for change* [Online]. Retrieved September 13, 2011 from http://www.plymouth.ac.uk/pages/view.asp?page=10494

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14. LDSHAKE AND THE "BIOLOGIA EN CONTEXT" TEACHER COMMUNITY ACROSS HIGH SCHOOLS

INTRODUCTION

Previous chapters present significant recent contributions around supporting authoring of learning designs, such as ScenEdit (Emin & Pernin, this volume Chapter 13), CADMOS (Katsamani, Retalis, & Boulakis, 2012) or OpenGLM (Derntl, this volume Chapter 12). Other multiple learning design tools have been also reported in the literature, as also explained in the previous chapters. Not surprisingly, every learning design tool is valuable and of interest because they address different requirements or design principles. These requirements and principles depend on issues discussed in Section 1 and 2 of this book, including the supported pedagogical methods, the characteristics of didactics or subject matters, the provision of reusable building blocks or templates, the exploitation of diverse representational approaches, the use of specific exporting formats to be compliant with learning systems, the use of desktop or mobile devices to support the activities designed, institutional practices, etc. (Britain, 2007; Griffiths et al., 2005; Hernández-Leo et al., 2007; Neumann et al., 2010; McKenney, 2008). Actually, it is not difficult to imagine teachers facing diverse educational situations in which they may require different learning design editors: designing activities for assessment in situ using mobile phones, creating rich collaborative activities that promote positive interdependence and individual accountability in a face-to-face scenario with the support of computers, designing a game for revising concepts at home, etc. However, a problem is that the existing tools are in disperse websites or product providers, and sometimes they may be easily unknown by the practitioners.

In addition, teachers are also currently facing situations in which they would benefit from the support for sharing and collaborative authoring. There exist emerging intra- and inter- educational institution initiatives where teachers work together on devising learning innovations via the design of new activities and the exchange of their experiences resulting from the application of the activities (Carrió et al., 2011; Vourikani, Gilleran, & Scimeca, 2011). However, the existing authoring tools do not offer co-editing or social sharing features. It is true that there are a number of digital repositories, such as Glow (2012), Agrega (Sarasa, Canabal,

M. Maina et al. (Eds.), The Art & Science of Learning Design, 195–210.

& Sacristán, 2009), EdShare (Davis et al., 2010), OpenLearn (McAndrew et al., 2008) and OpenCourseWare (Abelson, 2008) - among many others, devoted to supporting sharing and reuse of educational resources. There are also several portals more focused on learning design materials, such as AUTC (2012), Phoebe (2012), CloudWorks (Conole et al., 2008) and OITC (2012), some of them with interesting social-network facilities, however they do not support co-editing of learning designs and they are all oriented towards open collaboration. This limitation also applies to the existing teachers' communities, whose main features deal with supporting communication (Riding, 2001; Vourikari, Gilleran, & Scimeca, 2011).

In this chapter, we present the "*Biologia en Context*" teacher community (Catalan name, meaning "Biology in Context") and how its needs have grounded the iterative customization and extension of LdShake. LdShake is a Web tool that enables the co-editing and social network-oriented sharing of learning designs, which in the first version of LdShake could be created using a general rich text editor (Hernández-Leo et al., 2011b). The *Biologia en Context* community - officially recognized by the government of Catalonia – comprises teachers from 20 high schools distributed among the provinces of Catalonia. The teachers belonging to this initiative share the motivation of enhancing their teaching via the joint design of innovative activities fostering the situated learning of Biology topics.

Among other detailed requirements elaborated later in the chapter, *Biologia en Context* had two main needs. First, they required an on-line safe space to communicate, share their comments and preliminary designs they might not be sufficiently confident with. In this sense, LdShake had to provide them with a closed community support across their high schools. Though not explicitly present in this case, other issues that can lead to the selection of closed communities are situations in which teachers want to preserve and control the ownership of their materials or when the institutional preferred practice is to keep the resources locked into the institutional learning management system (Davis et al., 2010; RIN, 2008).

When the *Biologia en Context* teachers saw the first version of LdShake, they appreciated its co-editing, commenting and sharing facilities but they were not fully satisfied with the rich text editor provided (Hernández-Leo et al., 2011a). In particular, some of them claimed that for some activities they used eXeLearning (eXe, 2012) – an editor to which they were already familiar and that enabled them the creation of specific web learning designs. Yet, they wanted to also have the opportunity of using the rich text editor. Therefore, *Biologia en Context* teachers pointed out a second important need: LdShake had to integrate the various editors they may require according to their purposes or preferences. When consulted with other stakeholders, from educational technology providers, educational institutions responsible roles to teachers of diverse subject matters and educational levels, these stakeholders also considered the possibility of having multiple editors integrated in a common sharing and co-editing context of high interest (Hernández-Leo et al., 2011a).

After describing the *Biologia en Context* initiative, this chapter presents LdShake and how it has been customized to support the social network oriented work of this community requiring the use of several (co-)editors and sharing across institutions. Then, the chapter also reports the teachers' view around utility, usability and adoption aspects regarding the new customized version of LdShake.

THE "BIOLOGIA EN CONTEXT" TEACHERS' COMMUNITY

Biologia en Context is a High School Curricular Project fostering teaching and learning processes based on the use of real-life biology contexts. The curricular approach was initially designed as an adaptation of the well-known Salters-Nuffield Advanced Biology (SNAB) English project to the Catalan context. The SNAB project was developed in 2000 at the Nuffield Foundation in London and the University of York Science Education Group (Reiss, 2005). SNAB proposes the use of story-style contexts, biology applications, and active learning techniques supported by computers. As a result, students learn through a wide variety of activities, from standard laboratory tasks to model-building and role-play activities, always with the assistance of electronic tutorials and animations. In this context, teachers' tasks are focused on facilitating learning rather than on transmitting factual information. This approach promotes students' development of relevant science-related skills, such as experimental and research skills, including the ability to make judgments about the quality of scientific evidence.

The *Biologia en Context* project was started and coordinated by the Centre for Innovation in Science Education (CDEC, Catalan acronym) of the Catalan Department of Education in the 2004–2005 academic year. The project was implemented in 17 schools in 12 different cities in Catalonia and involved a total of 19 teachers. The implementation was actually evaluated along two academic years, from 2005 to 2007. The participating teachers formed a working group with the following objectives: master the SNAB didactic basis, participate in the design of the activities (lead by the project coordinators), experiment the new activities in their schools, evaluate its implementation, reflect about the results and propose improvements.

The evaluation results indicated that the students that participated in the *Biologia en Context* actions acquired a more meaningful learning of biology key concepts that the students following traditional courses. Moreover, the motivation and attitude towards science of the students participating in *Biologia en Context* improved significantly (Lope, 2009). Nevertheless, the results also indicated the need of improving the editing of the activity designs. The designs used were rudimentarily edited, what was pointed as a limitation both by teachers and students. The project coordinators also recognized that limitation and pointed out the need of offering teachers a solution that would enable them to more easily publish and share the activities. It was one of the teachers involved in the project who proposed to use eXeLearning (eXe, 2012) and a Creative Commons License. This issue was very important since it allowed the creation of educational activities in a Web format, easily publishable in Internet, making them accessible to all of the teachers in the project, but also opening the opportunity to spread the project to other high schools in Catalonia. Currently, some mature activity designs can be downloaded from the Website of the Catalan Department of Education but others are still under (co-) edition.

The *Biology in Context* teachers' community remains active since then, formally involving the teachers that implemented the original project and that keep redesigning, editing and updating the activities. Revising the activities is very important in *Biologia in Context,* since one of the basic features of contextualized learning activities is that their scenarios are up to date so that they are significant to the students. In fact, this is recognized as the major responsibility of the community: bringing the activities continuously up to date. To achieve this objective, the teachers typically distribute the work. Each teacher is typically responsible for at least two activities and one of the members plays the role of the coordinator. The coordinator organizes the different tasks and unifies the editing and the general frame of the educational units. Each teaching unit is composed of a wide range of activities, from 40 to 45. Examples of activities include an experiment to diagnose a genetic disorder such as cystic fibrosis, or a virtual debate about the problems suffered by people with genetic disease if they want to have children.

Before using LdShake, Teachers tended to meet only once a year, normally in small groups focused on a particular educational unit. Therefore, most of the work was performed via e-mail or using a forum opened in a Moodle platform. All of them agreed that adopting new tools to facilitate their virtual collaborative work would be very useful and could help to improve their efficiency.

The community is also currently facing a new challenge. Other teachers are starting to use the *Biologia en Context* activities, and there is a need to support them in the implementation, evaluating the new experiences and explicitly expanding the teachers' community actively involved in the design and revision of the activities. At the moment it is estimated that more than 30 high schools are adopting the *Biologia en Context* activities, but only the initial 17 schools can be tracked. In these circumstances, the *Biologia en Context* coordinators identified Ldshake as a relevant solution for the community. They appreciated the potential of LdShake to allow teachers to share and have conversations about the activity designs and their implementations in the schools, favoring educational research and innovation. Moreover, LdShake could provide them with a closed working space while at the same time facilitating the involvement of new members, making feasible a growing community.

Next section describes LdShake and how it has been extended and customized according to the needs of the *Biologia en Context* community. Their requirements were discussed by two coordinators of *Biologia en Context* with the researchers and developers of LdShake in a series of iterative face-to-face meetings. The face-to-face meetings were complemented with asynchronous communications by e-mail where advances in development were notified to the coordinators to provide feedback. When the achieved version of LdShake was satisfactory to the coordinators, it was then made available to the whole teachers’ community. Moreover, they were also invited to a workshop where the community coordinators and the LdShake developers showed and discussed with them the features of the platform.

RETHINKING LDSHAKE FOR “BIOLOGIA EN CONTEXT”

LdShake enables teachers to create and share learning design solutions (LdS) with other teachers (LdShakers) using different access rights so that they can read, comment or co-edit the designs in the frame of a closed community. The decisions and rationale behind its global design are introduced in (Hernández-Leo et al., 2011b). *Shake* serves as well as a metaphor which links the different main actions users, referred to as *LdShakers*, can perform with the tool: *shaking their hands with other teachers* (managing teams of colleagues with which they will share and co-edit contents), *shaking their students with the learning designs* (publishing or displaying the contents stored in the platform), *shaking different learning solutions* (finding interesting LdS made by other educators and collaborating in their edition), and finally *shaking up their way of working* (creating their own LdS and sharing them with other users).

LdShake *sharing* options are accessible via the button marked with letter (f) in Figure 1. In this way, each design solution can have associated a group of teachers able of working on its editing (LdShakers with writing rights) and another group that can only see the design (LdShakers with viewing rights). The LdS are organized in listings, accessible through menus in a top bar, as shown in Figure 1 (b). *My LdS* displays the LdS of which the user is the starter and the ones she has writing access to. *Browse LdS* lists all the LdS the user can read and comment. In those listings the tags associated to the LdS are shown in each of them and in a side bar, so that users can filter the LdS by selecting one of these tags. Editors can add *tags* to the LdS using a dialog box (e), which is below the *title* of the design (d). Tags can be of different types, depending on the needs of the community, and to an indication of the granularity (from fine grained activities to coarse grained courses or modules) and completeness (from an abstract pedagogical pattern to a refined ready-to-implement design) of the design according to the framework proposed in (Hernández-Leo et al., 2007). The profiles listed in *LdShakers* (c) also display the LdS that each LdShaker started and to which the user has access. As mentioned before, the designs can be commented and these comments are available for all the users that can view the design. The co-edits performed to an LdS are registered and can be visualized using a graphical representation that facilitates the tracking of changes by users and time. Moreover, the designs can be published so that a URL associated to that LdS is accessible outside the platform. The LdS can be also downloaded; the format depends on the editor with which the designs have been created.

Figure 1. Screenshot of LdShake when editing an LdS using eXeLearning (out of the three editors available when creating a new design (Nou LdS): Rich Text, eXeLearning and WebCollage). Some of the features of LdShake are marked with letters (a-g).

The first version of LdShake included a Rich Text editor not specifically focused on learning design (Hernández-Leo et al., 2011b). When presented to the *Biologia en Context* initiative, the main concern of the teachers was how to take advantage of the amount of designs that they had already created with eXeLearning. Reasonably, re-authoring all these resources was a tedious job, so it was decided to import them into LdShake in a read-only mode, in PDF format. However, this solution hindered the possibilities of co-editing and creation of new designs with eXeLearning in the context of LdShake.

The identification of this problem in this specific context led us to rethink LdShake and follow an integrative approach (Hernández-Leo et al., 2011a). Instead of extending the already provided general editor to enhance specific aspects of its support for learning design, LdShake can act as a platform that adopts existing learning design authoring tools which support diverse pedagogical approaches, are compliant with different computational representations or exporting formats, are specific to particular subject matters, or are already familiar to the users. The foremost interest of the integrative approach relies on that the learning design editors integrated can be visualized within the same contextual interface and take up the co-editing and sharing features of LdShake.

Therefore, in the new version of LdShake the editing page becomes either a canvas where to embed a specific third-party editor, or the LdShake native editing pane, which is the Rich Text editor (in terms of data formats, native LdS are collections of HTML documents with added metadata). Figure 1 already shows the result of embedding the eXeLearning editing form into the LdShake platform. (g) in Figure 1 points out the third-party form, and the rest of the controls, as explained before, are the core LdShake features (sharing options, tagging and editing of the metadata). As a proof of concept that more editors can be also integrated, the WebCollage editor is also provided within the new version of LdShake. WebCollage is an extension of Collage, a pattern-based collaborative learning design editor compliant with IMS Learning Design (Hernández-Leo et al., 2006), which is now web-based and incorporates assessment patterns (Villasclaras et al., 2009). Users can select any of the editors available, Rich Text editor, WebCollage and eXeLearning, when creating a new design (a), and they all adopt the same approach concerning sharing and co-editing since the above mentioned features are supported now by these editors when used within the LdShake platform.

In order to achieve this suitable integration of the two external editors into LdShake (i.e., to allow the user to perform all the operations that can be done with native LdS), a revision tracker has been developed for both external tools so that the revision history can be represented visually, and a PDF export tool has been also built for the case of eXeLearning. The latter feature has been particularly asked by the teachers of *Biologia en Context*, as being able to print the materials is regarded as a strong need.

In addition to these major modifications, some other improvements and slight changes have been implemented for the particular needs of this community. Although being minor, we reflect these changes here, as they can be decisive in real-world learning design communities. Firstly, all the interface of LdShake (initially presented in English) has been translated into Catalan. To accomplish this task, a simple but straightforward translation module has been developed. In this way the platform becomes easily translatable into other languages (by translating an auto-generated file containing all the copies of the website and setting the appropriate language). Also, some browser-specific instructions have been added for the teachers to ensure complete compatibility with the website. Figure 2 shows a portion of the welcome page, translated into Catalan and with these instructions.

The platform has also been populated with the 160 designs the community had already created using eXeLearning. Thanks to the performed integration, they could be imported automatically. Moreover, to facilitate the task of browsing the designs, the *Biologia en Context* coordinators asked that the designs were sorted alphabetically in the listings (b), instead of by time of last update (as implemented in the previous versions of LdShake). They also requested specific pre-defined tags and categories for the tags. The base implementation of the platform defines three kinds of tags: Discipline, Pedagogical approach and Free Tags. To better accommodate the requirements of *Biologia en Context*, two of these types of tags were substituted. Subject and Activity Type were introduced in exchange for Discipline and Pedagogical approach. These two new categorizations allowed the designs to be classified in a balanced and meaningful way. Free Tags was left available for custom categorizations.

Figure 2. LdShake welcome page adapted to Biologia en Context

Another minor but important change relates to the e-mail notification system. By default, LdShake is quite conservative in terms of sending notification e-mails to the LdShakers' inboxes: it only sends e-mails to the directly affected users (e.g. it sends an e-mail to the starter of a resource when some other user comments it). In the case of *Biologia en Context*, and in order to increase the group awareness, the visibility of each user contribution to the platform has been maximized. Concretely, an e-mail is sent to all the LdShakers both when a new LdS is created and when another user comments an existing LdS. In this way, and just by reading their inboxes, the teachers have an overview of the activity happening on the platform, and as they contain links to the resources, these e-mails act as "hooks" to direct teachers to the platform and ultimately foster their participation in the community.

Finally, a generic enhancement has been implemented to the website responding to the demands of the *Biologia en Context* teachers after analyzing their reactions to the new version of LdShake (reported in next section of this chapter): a full-text search engine where the entire designs are indexed, so they become easily searchable within the platform. The base version allowed the filtering of resources by listings and tags, but not text-based searches. Given the amount of activities involved in *Biologia en Context*, the need for this feature was salient.

TEACHERS' VIEW: UTILITY, USABILITY AND ADOPTION

The customized version of LdShake has been shown to the teachers belonging to the *Biologia en Context* community in a hands-on workshop. During the workshop, teachers could explore and use its main facilities. A total of 13 teachers of 12 different high schools completed an on-line form at the end of the workshop. The form consisted of a section devoted to collect information about their profiles (high school in where they work, teaching experience, reasons behind their motivation to participate in the *Biologia en Context* initiative, previous use of LdShake) and a second section with questions about utility, usability and adoption aspects. These later questions included a set of Likert scale items and open comments to explain the ratings (justification of the ratings, decisive aspects that would lead them to use LdShake, how LdShake may change their practices, and other open comments). Some of the items and open questions were explicitly related with utility, usability or adoption, but most of them were actually interrelated since utility and adoption cannot be often separated from usability (Grudin, 1992; Hu et al., 2003).

The reported average number of years of teachers' experience was 20, ranging from 12 to 25 years. They already knew about the previous version of LdShake (Hernández-Leo et al., 2011b), however only three of them had actively used it. When asked about their main motivation behind their participation in the *Biologia en Context* initiative, seven (out of the 13) teachers claimed benefits regarding enhancement in students' learning. These teachers' assertions were aligned. For example, they said, "It (*Biologia en Context*) has led me to a new way of teaching fostering self-learning and learning guided on the side… Contextualization places students in everyday situations, making more sense of the knowledge they discover…", "It makes Biology more interesting to the students, more practical and more encouraging", "Students participate actively in their own learning through very diverse activities". However, five teachers referred to the opportunity of belonging to a community as their main stimulus. These teachers said that their main motivations are "The possibility of sharing the creation of materials and classroom experiences", "Sharing activities and opinions", "Belonging to a working team and having the possibility of sharing activities, commenting them, sharing experiences…", "Exchanging activities, opinions and working in group", "Sharing good practices". Finally, one teacher did not point out to a specific motivation but to her future expectations, "I've been part of *Biologia en Context* for seven years and strongly believe in it its benefits. I think that the possibility of being able to modify and update the activities would even increase the value of our initiative".

Table 1 gathers the results of the Likert scale items. Though the number of teachers answering the items is not high, the standard deviation in their ratings offers an indication of a trend in the level of agreement among the teachers. These results show that, though with a significant deviation in the answers, the perceived easiness of use of LdShake is still a challenge (a). In a scale from 1 to 7, where 1 means disagreement and 7 means strong agreement, five teachers rate "ease of use" neutrally (with a 4). This item has also the lowest rating when compared with other items. Yet, when looking at the teachers' comments regarding their ratings, one of them said that her rating had to do with her limited technological skills and not with the tool itself. Three other teachers explained their answers pointing out workload / time limitations. They said, "I really believe that the tool can be very useful, but it is another tool to incorporate to our way of working; and this implies the need of more time and effort", "LdShake can be very useful. But we are already using many tools, the institutional learning management system (Moodle), book publisher platforms…", "Teachers need to make great efforts to learn software tools… and we don't have all the time in the world".

Table 1. Teachers' ratings about utility, usability and adoption aspects(scale of 1 – 7, 1 meaning disagreement with the statement and 7 strong agreement)

Utility, usability and adoption aspectsrated by the teachers	*Distribution of ratings rating(#teachers)*	*Average of ratings*	*Standard deviation*
(a) I believe LdShake can be quite easy to use	**4(***5***)**-5(*2*)-6(*3*)-7(*3*)	5,3	1,3
(b) I believe that it is worth getting used to LdShake, since it can be very useful for us	4(*1*)-5(*4*)-**6(***6***)**-7(*2*)	5,7	0,9
(c) I believe that the more colleagues use actively LdShake, the more I'll use it myself	4(*1*)-5(*4*)-**6(***5***)**-7(*3*)	5,8	0,9
(d) I believe that LdShake will be useful for us as a repository of the educational activities we use in *Biologia in Context*	4(*1*)-5(*1*)-**6(***9***)**-7(*2*)	5,9	0,8
(e) I believe that commenting the activity designs at LdShake will be useful for future revisions of these materials	5(*1*)-**6(***10***)**-7(*2*)	6,1	0,5
(f) I believe that commenting the activity designs at LdShake will be useful to exchange experiences about the use of these materials with the students	4(*1*)-5(*2*)-**6(***8***)**-7(*2*)	5,8	0,8
(g) I find useful the possibility of modifying the existing activity designs available at LdShake	4(*2*)-5(*1*)-**6(***5***)-7(***5***)**	6,0	1,1
(h) I find useful the possibility of creating new activity designs in LdShake	4(*1*)-5(*4*)-**6(***5***)**-7(*3*)	5,8	0,9
(i) I believe that the possibility of exchanging / sharing activity designs with other colleagues of our high school will be useful (if they would like to join the *Biologia en Context* community)	1(*1*)-4(*1*)-5(*2*)-**6(***7***)**-7(*2*)	5,5	1,6
(j) I believe that the possibility of exchanging / sharing activity designs with colleagues of other high schools belonging to the *Biologia en Context* community will be useful	5(*4*)-**6(***8***)**-7(*1*)	5,8	0,6

Utility, usability and adoption aspectsrated by the teachers	*Distribution of ratings rating(#teachers)*	*Average of ratings*	*Standard deviation*
(k) I believe that I will share with all the community members registered in LdShake the activity designs that I will be adding	4(*2*)-5(*2*)-**6(***8***)**-7(*1*)	5,6	0,9
(l) I believe that the LdShakers menu section will be useful for us to follow the work of other *Biologia en Context* colleagues	5(*2*)-**6(***9***)**-7(*2*)	6,0	0,6
(m) I believe that it will be useful to have several editors integrated in LdShake, including eXeLearning and a rich text editor	3(*2*)-5(*1*)-**6(***7***)**-7(*3*)	5,7	1,3
(n) I believe that the organization of activity designs by sections and tags will be useful	5(*2*)-**6(***7***)**-7(*4*)	6,2	0,7
(o) I think that publishing the activity designs and obtaining a public URL or the eXeLearning package, accessible outside LdShake, will be useful for us	4(*1*)-5(*2*)-**6(***5***)-7(***5***)**	6,1	1,0

However, all of the teachers recognized the utility of LdShake and most of them agreed that it is worth getting used to it (b). A teacher specified, "It (LdShake) can be an effective tool to share proposals of activities to the community or to smaller groups that we can form to work on particular topics". The answers to item (c) suggested that a teacher's own use and perceived usefulness of the tool will be influenced by the active adoption of the tool by her peers. As one of them stated, "I feel confident about being able to incorporate this tool to my everyday work, if we all do so…"

Regarding the facilities and affordances of LdShake, high average ratings (over 6 in the likert scales) were given to statements that go beyond the simple provision of a repository (d), such as the organization of the activity designs using sections and community-adapted tags (n), the LdShakers menu section enabling teachers to follow the activity of other members in the community (l) and the possibility of linking or downloading the designs outside the community using an assigned published URL (o). A teacher pointed out, "Being able to directly use the materials in Moodle is very, very useful…" Besides, there was a clear consensus on the utility of the commenting facility for performing future revisions to the activity designs (e). Being able to actually make modifications to the activity designs using LdShake was actually the utility statement on which more teachers strongly agree (g); five teachers rated this statement with a 7 and other five teachers rated it with a 6.

Though with less emphasis in the ratings, the teachers also found useful to use LdShake to exchange experiences about the application of the activities in their classrooms (f), to create new activity designs (h) and to share these activities with some or all the members of the *Biologia en Context* community (k). Though it was not a completely shared feeling, 10 teachers clearly believed in the possibilities of having several editors integrated in LdShake, including eXeLearning (m). Regarding the provision of several integrated editors and the publishing option, a teacher comments, "It (LdShake) can be a good tool to edit the materials and publish them at the same time. And we work with different formats…" Interestingly enough, all of the teachers agreed on the opportunities provided by LdShake to share activity designs with *Biologia en Context* colleagues from other high schools (j). However, there is a significant deviation in their level of agreement in the item stating that the platform could be useful to share designs with colleagues in their same high school eventually joining the community (i).

When specifically asked about "the decisive aspect" that would lead them to use LdShake, the majority of the teachers (8) provided an answer related to the level of participation of their colleagues in the community. They explicitly indicated, "The regular participation and exchange of opinions", "Seeing the group working actively", "A high level of participation", "Knowing the comments of the colleagues about the activities", "Generalized and agile use by all of us", "That we all use it habitually", "Fluid contributions and communication between all of us", "Being able of co-creating activities with other teachers". Three teachers, however, were more worried about the time limitations and pointed out as their decisive aspect, "Having time available", "Confirming that I can save time using the tool, and not the other way around", "The time that I need to master the tool".

Teachers revealed five different aspects of their current practice that will change when they use LdShake. These aspects reflect enhancements that have to do with communication ("common place to bring our opinions and ideas together"), evolution of the activities ("easier introduction of comments and modifications to the activities"), sharing ("easier sharing of our work, seeing and taking advantage of others' work"), creation ("improvement of my own materials") and access to the designs ("no more need of paper photocopying nor of USB memories"). In the additional open comments, teachers asked for a searcher integrated in the tool (which, as told in the previous section, was finally implemented) and the incorporation of additional organization tag. Nevertheless, their main request, shared by half of the teachers, was the organization of advanced follow-up training sessions to strengthen their confidence with the use of the tool functionalities.

DISCUSSION

The *Biologia en Context* community comprises Biology teachers from several high schools distributed among the Catalan geography. Their goal is to enhance Biology learning by designing their own situated learning activities that are framed in up-to-date real contexts. *Biologia en Context* is a significant case showing the interest of providing practitioners with on-line community spaces and support for co-editing and sharing using diverse existing learning design editors within the same platform. LdShake provides the *Biologia en Context* teacher community with a closed safe space to communicate, share comments and preliminary learning designs. Preparing the specific installation of LdShake that support the needs of this community has led us to transform the tool into an integrated platform that embeds existing web learning design editors. Different teachers’ communities willing to share and collaborate in learning design endeavors show to have preferences or experience in the use of authoring tools that are relevant to their context and practices. Other lessons learnt from this case that can be extrapolated to other cases and supporting platforms include the practical teachers’ need of a printable format for the designs, the relevance of teacher-generated taxonomies to tag the designs, and the provision of a notification system (connected to teachers’ e-mail addresses) that keeps teachers aware of the activity in the platform.

Overall, customizing the platform to the needs of the *Biologia en Context* community has shown to be a relevant step to foster the adoption of LdShake in this particular case. Teachers value highly the usefulness of the platform, which is compatible with their previous practices and enhance them. They also perceive that LdShake is relatively easy to use. After the workshop, the observed adoption of the platform is moderate. In general, teachers (26 teachers from 20 different High Schools, half of them participated in the workshop) use the platform mostly as a repository of their designs, where they comment and make small editions to update these already available designs. Only a small number of new designs have been created, and the coordinator has started most of them. To use the designs in the classroom they print PDF documents of the designs, or use an eXeLearning installation for the students (LdShake is meant to be used only by the teachers).

Feedback meetings with the *Biologia en Context* coordinators confirm the usefulness and usability of the platform - as experienced by the teachers in the continuous usage of the platform. Yet, challenges under discussion to foster a higher adoption and feature exploitation are related to the level of teacher training provided, the teachers’ workload, the degree of adoption by peers, and developing a culture of actual collaboration that goes beyond untied cooperation.

The *Biologia en Context* teacher community is planning to grow in the next academic years, involving especially recently graduated teachers in the area of Biology and Geology, who are motivated in devoting time to create new materials. This profile of teachers is also in general more familiar to social networks and web tool features, and their adoption of LdShake is expected to be stronger. Indeed, the current members of the community consider that LdShake can play a relevant role in supporting a growing community where a culture of actual collaboration can be more easily developed.

On the other hand, LdShake has been recently released as open source (downloadable from SourceForge), available for teachers’ communities to create their own installations and adapt it according to their particular situations. Besides, LdShake will be further extended in the European METIS project where additional learning design tools will be integrated to support the complete learning design cycle (from authoring to enactment). An API will be developed and make available for developers of LdS authoring tools to store their materials into LdShake's platform and to show their editor in the LdShake's edition pane so they could be shared, co-edited, commented and exported in the same manner that the current LdS allow. The METIS project will also develop workshop packages to promote the adoption of the integrated environment, which will be used by at least teachers' communities of three European educational institutions in the sectors of vocational training, adult education and higher education.

Hopefully, the incremental adoption of LdShake and the related projects will bring to light more evidences regarding the feasibility in real practice of the ultimate goal that is behind the focus of this book: teachers acting as learning designers immerse in culture of sharing and collaboration.

REFERENCES/BIBLIOGRAPHY

Abelson, H. (2008). The creation of open course ware at MIT. *Journal Science Education and Technology*, *17*(2), 164–174.

AUTC. *Learning designs, products of the AUTC project on ICT-based learning designs*. Retrieved 1 March 2013, from http://www.learningdesigns.uow.edu.au

Britain, S. (2007). Learning design systems: Current and future developments. In H. Beetham & R. Sharpe (Eds.), *Rethinking pedagogy for a digital age* (pp. 103–114). New York, NY: Routledge.

Carrió, M., Larramona, P., Baños, J. E., & Pérez, J. (2011). The effectiveness of the hybrid problem-based learning approach in the teaching of biology: A comparison with lecture-based learning. *Journal of Biological Education*, *45*(4), 229–235.

Conole, G., Culver, J., Williams, P., Cross, S., Clark, P., & Brasher, A. (2008). *Cloudworks: Social networking for learning designs* (187–196). Melbourne, Australia: Ascilite Conference.

Davis, H. C., Carr, L., Hey, J. M. N., Howard, Y., Millard, D., Morris, D., & White, S. (2010). Bootstrapping a culture of sharing to facilitate open educational resources. *IEEE Transactions on Learning Technologies*, *3*(2), 96–109. doi:10.1109/TLT.2009.34

eXe, eXeLearning – The eLearning XHTML editor. Retrieved March 1, 2013 from http://exelearning.org/wiki

GLOW. *Scotland intranet for education*. Retrieved March 1, 2013 from http://www.ltscotland.org.uk/glowscotland/index.asp

Griffiths, D., Blat, J., García, R., Vogten, H., & Kwong, K. L. (2005). Learning design tools. In R. Koper & C. Tattersall (Eds.), *Learning design*: *A handbook on modelling and delivering networked education and training* (pp. 109–135). Heidelberg: Springer-Verlag.

Grudin, J. (1992). Utility and usability: Research issues and development context. *Interacting with Computers*, *4*(2), 209–217.

Hernández-Leo, D., Abenia, P., Moreno, P., Chacón, J., & Blat, J. (2001a). *Let's shake on it: Can we support co-editing and sharing using diverse learning design editors within the same platform?* The art & science of learning design workshop, LKL, London, 13–14 October 2011. Retrieved March 1, 2013 from http://www.slideshare.net/yish/asld2011-hernndez-leoabeniamorenochacnblat

Hernández-Leo, D., Villasclaras-Fernández, E. D., Jorrín-Abellán, I. M., Asensio-Pérez, J. I., Dimitriadis, Y., Ruiz-Requies, I., & Rubia-Avi, B. (2006). Collage, a collaborative learning design editor based on patterns. *Educational Technology & Society*, *9*(1), 58–71.

Hernández-Leo, D., Harrer, A., Dodero, J. M., Asensio-Pérez, J. I., & Burgos, D. (2007). A framework for the conceptualization of approaches to "Create-by-Reuse" of learning gesign solution. *Journal of Universal Computer Science*, *13*(7), 991–1001.

Hernández-Leo, D., Romeo, L., Carralero, M. A., Cachón, J., Carrió, M., Moreno, P., & Blat, J. (2011b). LdShake: Learning design solutions sharing and co-editing. *Computers & Education*, *57*(4), 2249–2260.

Hu, P. J. H., Clark, T. H. K., & Ma, W. W. (2003). Examining technology acceptance by school teachers: A longitudinal study. *Information & Management*, *41*(2), 227–241.

Katsamani, M., Retalis, S., & Boloudakis, M. (2012). Designing a Moodle course with the CADMOS learning design tool. *Educational Media International*, *49*(4), 317–331. doi:10.1080/09523987.2012.745771

Lope, S. (2009). Evaluation of the experimentation carried out in the "Biologia en Context" project - Adaptation of Salters-Nuffield Advanced Biology (SNAB) to high school education in Catalonia (in Catalan). PhD Thesis. Barcelona, Spain: Universitat Pompeu Fabra, Barcelona.

McAndrew, P., Santos, A., Lane, A., Godwin, S., Okada, A., Wilson, T., et al. (2008). *Open learn research report.* Milton Keynes, England: The Open University.

McKenney, S. (2008). Shaping computer-based support for curriculum developers. *Computers and Education*, *50*(1), 248–261.

METIS. (2013). *METIS project website*. Retrieved March 1, 2013, from http://www.metis-project.org/

Neumann, S., Klebl, M., Griffiths, D., Hernández-Leo, D., Fuente, L., Hummel, H., et al. (2010). Report of the results of an IMS learning design expert workshop. *International Journal of Emerging Technologies in Learning*, *5*(1), 58–72.

OICS. *Open ICOPER Content Space*. Retrieved March 1, 2013, from http://www.icoper.org/open-content-space

Phoebe. *Pedagogic planer*. Retrieved March 1, 2013, from http://www.phoebe.ox.ac.uk/

Reiss, M. J. (2005). SNAB: A new advanced level biology course. *Journal of Biological Education*, *39*, 56–57.

Riding, P. (2001), Online teacher communities and continuing professional development. *Teacher Development*, *5*(3), 283–296.

Sarasa, A., Canabal, J. M., & Sacristán, J. C. (2009). *Agrega: A distributed repository network of standardized learning objects.* 10th International Work-Conference on Artificial Neural Networks (pp. 466–474). Salamanca, Spain.

Villasclaras-Fernández, E. D., Hernández-Leo, D., Asensio-Pérez, J. I., & Dimitriadis, Y. (2009). Incorporating assessment in a pattern-based design process for CSCL scripts. *Computers in Human Behavior*, *25*(5), 1028–1039.

Vourikari, R., Gilleran, A., & Scimeca, S. (2011). *Growing beyond innovators – ICT-Based School Collaboration in eTwinning, the 7th European Conference on Technology Enhanced Learning, Lecture Notes in Computer Science 6964* (pp. 542–537). Berlin & Heidelberg: Springer.

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15. ISIS AND SCENEDIT

An Intention-Oriented Learning Design Framework

INTRODUCTION

Various theoretical constructs have been proposed to capture abstractions enabling the design of learning situations featuring digital technologies. Among these, we can refer to *Educational Modelling Languages* (EML) (Koper & Tattersall, 2005) and *pedagogical design patterns* (Dimitriadis, Goodyear & Retalis, 2009; Mor & Winters, 2007; Hernández-Leo et al., 2006; Derntl & Motschnig-Pitrik, 2005; Goodyear et al., 2004), in particular. As noted by IMS-LD authors, an EML, which aims to provide interoperable descriptions of learning scenarios, is not intended to be directly manipulated by teachers or engineers: specific authoring systems (Murray & Blessing, 2003; Koper, 2006; Botturi et al., 2006) must be provided to allow designers to design scenarios at a lower cost. Pedagogical design patterns capture recurring features across narratives, encapsulating critical challenges and forces pertaining to an area of learning design, the interactions between them and possible solution methods. Within this approach, Laurillard & Ljubojevic put forward a tool, the Pedagogical Pattern Collector (PPC), to model the design, abstraction and interpretation of pedagogical patterns operationally.

The first generation of EML editors was developed based primarily on technical challenges. The main objectives of these tools were (a) to easily transform designers' specifications into implementation features and (b) to ensure interoperability so that learning scenarios could be exchanged between technical platforms, e.g., Learning Management Systems. However, the editors available, which made use of modelling techniques stemming from computer science (such as UML), were considered too complex to be mastered by teachers (Koper & Tattersall, 2005).

The second generation of editors, which includes tools such as LAMS (Dalziel, 2003) and CompendiumLD (Conole et al., 2008), offers a different, so-called "tool-box oriented" approach. LAMS offers a series of components at different levels, representing activities that can be combined to create a scenario. Although LAMS provides patterns for activities and repositories for sharing scenarios, it does not allow the designers to explain the choices they make regarding design or re-use from a didactical or pedagogical perspective. CompendiumLD is a software tool for designing learning activities using a flexible visual interface. It provides a set

M. Maina et al. (Eds.), The Art & Science of Learning Design, 211–226.

of icons that represent the components of learning activities. These icons may be dragged and dropped, and then connected to form a map representing a learning activity. This is a tool that supports practitioners by helping them to articulate their ideas and map out a design or learning sequence, but it cannot assist a designer starting with a blank canvas and like LAMS, it does not allow them to explain the choices made.

The third generation focuses on "visual instructional design languages" (Botturi & Stubbs, 2008) derived from generic modelling languages such as UML (Booch et al., 2004). According to the aforementioned authors, these tools are still too complex for a non-technical user: "editing facilities need to be more accessible to non-technical users so as to develop, implement, simplify and further the use of this type of case study in reality".

Specific conceptual models and authoring systems must be provided (Botturi & Stubbs, 2008) to help practitioners design their own scenarios using patterns and vocabulary more closely related to their own practices. The fourth generation comprises learning design authoring tools aimed at practitioners with no IMS-LD or UML expertise and which offer sharing and re-use features such as patterns and repositories. Most of the tools presented in this book can be considered as belonging to this category. For instance, the Open Graphical Learning Modeller (OpenGLM, Derntl & al., 2011) is a learning design authoring toolkit that supports the authoring of IMS Learning Design (LD) learning units at levels A and B. The activities are displayed in graphical form and arranged by the designer, and may be freely defined or imported from existing patterns. Other tools, models and patterns compliant with IMS-LD levels A and B have been designed for specific communities such as CSCL designers (CADMOS, CELS, WebCollage, the 4Ts model).

Thus, our research focuses on authoring environments aimed at specific designers: teachers who make use of digital technologies in the French secondary education system. In this specific context, teachers themselves design a scenario incorporating digital resources and tools, which they may potentially use in their classroom. Economic constraints do not allow a team of designers or developers to assist each teacher: it therefore becomes necessary to provide authoring tools that allow teachers to express their requirements based on their own business-specific languages and shared practices. Two goals are combined: first, to provide a "computable" description that can be translated into an EML (such as IMS-LD) and second, to be understood and shared by experts and practitioners who share a common vocabulary, knowledge of the discipline and pedagogical know-how. This authoring approach aims to further consider the requirements of learning scenario designers and the "business process" dimension of learning scenario design, which have formed the subject of a great deal of work in the fields of Systems Engineering and Software Engineering. Our research focuses, in particular, on work relating to Goal-Oriented Requirement Engineering (Van Lamsweerde, 2001), where the elicitation of goals is considered as an entry point for the specification of software systems, as is the case in the Rolland and Prakash MAP model (Rolland et al., 1999).

With this purpose in mind, we provide authoring tools that allow teacher-designers belonging to communities of practice to design their scenarios while expressing their intentions and the strategies they have adopted.

This paper is organized into four sections after the introduction. In section 2, we describe our context, our goals and the conceptual framework we propose: ISiS (Intentions-Strategies-Interactional Situations), which structures the design of learning scenarios. In section 3, we set out the main functionalities of the ScenEdit authoring environment aimed at teacher-designers by presenting an example. Before concluding the paper, in section 4 we describe the pilot experiments performed using the tools we have developed based on the ISiS model.

CONTEXT OF THE RESEARCH AND THE ISIS CONCEPTUAL MODEL

Context of the Research and Methodology

The research work presented in this paper was a collaborative effort between the Laboratoire Informatique de Grenoble and the INRP[1]. This collaboration closely involved groups of teachers in charge of co-developing and testing the models we put forward. The research led us to study existing practices for scenario sharing. In parallel with the work on EML-based formalization (Koper & Tattersall, 2005) presented above, a number of international initiatives have been geared towards offering scenario databases that favour sharing and re-use between teachers, such as the IDLD (Lundgren-Cayrol et al., 2006). Their goal is to disseminate innovative practices through the use of digital technologies in the field of education. These databases for teacher-designers, which include those proposed by the French Ministry of Education, EduBase and PrimTice, list indexed scenarios featuring different fields depending on the subject. Their descriptions are very heterogeneous, ranging from the narration of practices to more structured formalizations. This diversity has led us to question whether these representations can be understood and shared by several practitioners.

Our research is at the intersection of the two approaches identified previously: (a) proposing scenario databases that favour sharing and allow practitioners to make use of technology and (b) proposing computational interoperable formalisms (such as IMS-LD) to describe scenarios. The purpose of our research is to make it easier for teachers to design and implement learning scenarios using Information and Communication Technology, by providing them with formalisms and tools that meet the criteria of clarity, adaptability and suitability. In this context, we suggest designing learning scenarios by explicitly expressing intentions and learning strategies.

We organized our work into four phases and closely involved teachers with an interest in the topic of learning scenarios design (Emin et al., 2009). After a preliminary stage during which we precisely defined the targeted audience, the first phase involved analysing how scenarios are currently shared and reused. Teachers expressed difficulty in identifying the general objectives or the pedagogical approach used within such scenarios, despite the fact that these criteria are central for them. After completion of this process, teachers suggested that the design task could be made easier by providing libraries of typical strategies, scenarios or situations, with various granularities. Each of these components would need to be illustrated by concrete examples. These results made it possible to develop an intention-oriented model in collaboration with the teachers during the second phase of work: the ISiS model, which structures the design of a scenario. In the third phase, we trialled the ISiS model with a pilot group of teachers using textual forms and graphical representations. In the fourth phase, during which the design experiment was assessed, we tested several tools that implemented the ISiS model (paper forms, diagram designer, mind mapping software and a first attempt at a dedicated software tool) with audiences not yet involved in our research. We set up an experiment (Emin et al., 2009) to compare perceptions of the three types of formalism being studied: narrative, computational and structural. The purpose of this phase was to validate our assumptions and to assess our model and its first implementation, before embarking upon new developments.

In the next section we describe the ISiS intention-oriented conceptual model.

The ISiS Model

Within the scope of this research work we have combined different approaches to the teacher's design process: (a) organizing the scenario by formally eliciting the designer’s intentions and explicitly representing the learning strategies chosen and (b) allowing reusable components and patterns to be explored in libraries tailored to specific communities of teachers. To this end, we have co-developed the ISiS (Intentions, Strategy and interactional Situations) intention-oriented conceptual model. This framework specifically identifies the intentional, strategic, tactical and operational dimensions of a learning scenario. ISiS aims to capture the teachers’ intentions and strategies, to make it easier to understand scenarios written by others and thus favour sharing and re-use. ISiS is not an alternative to EMLs, but it complements them by offering higher-level models, methods and tools designed for and with teacher-designers. In parallel with the development of the ISiS model, teachers have assisted us in co-designing a series of software prototypes that make progressive use of ISiS concepts.

According to the ISiS model (see Figure 1), the organization and planning of a learning unit can be described with a high-level *intentional scenario* that reflects the designer’s intentional and strategic dimensions. An *intentional scenario* organizes the scenario into different *phases* or *cases* by examining *intentions* and *strategies*. Each phase or case can either be recursively refined by a new intention or linked at a tactical level to a suitable *interactional situation*. An interactional situation can itself be described by a lower-level *interactional scenario* which defines, in operational terms, the precise organization of situations (in terms of activities, interactions, *roles*, *tools*, services, *resources* provided or produced, etc.). Interactional scenarios inhabit the operational level that is typically illustrated using examples of EML implementation.

Figure 1 provides an overview of the ISiS model, which is geared towards structuring the design of a scenario describing the organization and planned execution of a learning unit.

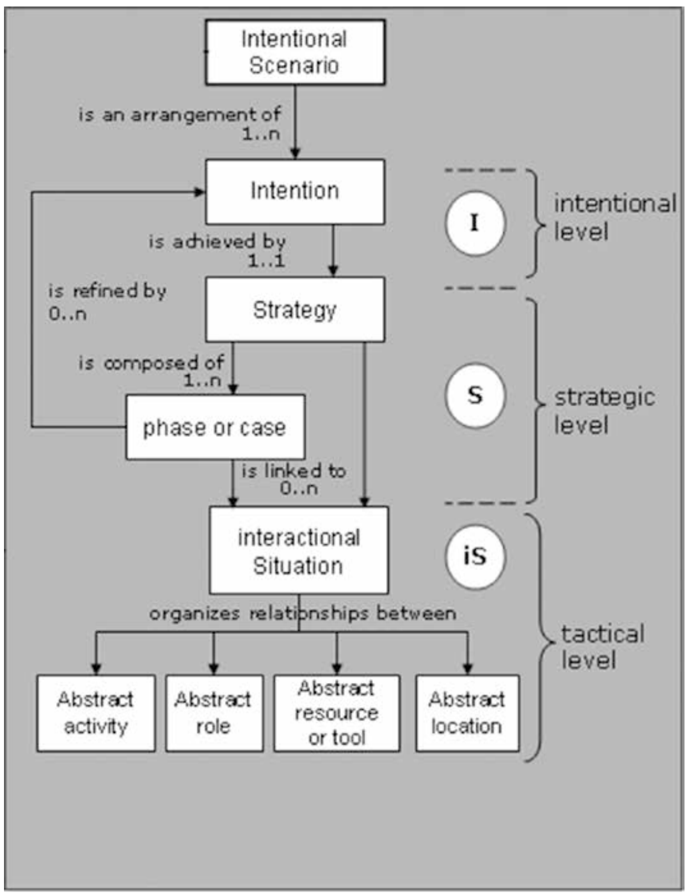

Figure 1. An overview of the ISiS model

- The *I level* (Intention) describes the designer's intentions. In our field, intentions are closely linked to the knowledge context, which defines targeted knowledge items (concepts, notions, skills, know-how, abilities, conceptions, misconceptions, etc.). For example, the designer's intentions may be to reinforce a specific skill in the area of electrical engineering, to favour the discovery of a notion, to dispel a frequent misconception, etc.

- The *S level* (Strategy) relates to strategic aspects. In order to reach the goals relating to the intentions formulated at the I level, the designer opts for the strategy he considers the most appropriate. Two main types of strategy can be distinguished: sequencing strategies, which organize the arrangement of logical phases (e.g., a scientific inquiry strategy can be modelled as a series of four phases), and distribution strategies, which plan out different solutions to identified cases (e.g., a differentiation strategy takes into account three possible levels of mastery). Strategies can be combined through successive refinements. For instance, a sequencing strategy may incorporate one of the cases of a distribution strategy.
- The *iS level* (interactional Situation) represents the tactical level, i.e., the solution proposed to implement the intentions and strategies formulated. We consider that, when faced with a new problem, a teacher-designer does not build a new and specific solution from scratch. As underlined in works on schemata and routines in teaching activities (Schank & Abelson, 1977), the teacher bases his planning or his adjustments on a library of pre-mastered solutions, which are triggered by specific events. Similarly, we assume that a scenario designer selects situations that are appropriate for his intentions and strategies from a whole library of patterns. Each *"interactional situation"* is defined as a set of interactions with a specific set of *roles, tools, resources and locations* according to the *situational context*. The situational context is defined at an "abstract" level, which means that only typical elements are listed (e.g., word processors, mind maps, etc.). Physical spaces are represented by the *locations* item, which refers to typical abstract locations: classroom, home, location with an internet connection, etc. For example, in order to specify a "solution development phase" scenario in a collaborative way and for distance learners, a designer can choose a typical situation known as "argued debate on a forum leading to consensus". In another context, e.g., pupils who have difficulties at school, a more personalized situation can be used, such as "choosing a solution from among all possible proposals using an MCQ tool".

The ISiS model proposes to clarify the higher levels (I, S and iS) that are generally used but not explicitly defined by current methods and tools. In parallel with the development of the ISiS model, we have worked with teachers to co-design a series of software prototypes that progressively implement ISiS concepts. We will now present these implementations and the web version of ScenEdit.

IMPLEMENTATION OF THE ISIS MODEL

Towards Flexible and Continued Design Processes

The ISiS framework is not a method per se, as it does not propose a specific order for combining design steps. ISiS is based on the hypothesis that all dimensions of a scenario (intentions, strategies, situations, activities and resources) must be elicited and interlinked in order to facilitate design, understanding, sharing and re-use. In our experiments, we analyzed the tasks carried out by teacher-designers (Emin et al., 2009). Several design processes illustrated by different studies involving teacher-designers were considered. Some teachers were able to choose a top-down approach by hierarchically defining their intentions, strategies, situations, etc., while others preferred to adopt a bottom-up approach by "rebuilding" a scenario from the resources or patterns that they wanted to include. Consequently, one of our hypotheses states that the design of a learning scenario cannot be modelled as a linear process without significantly reducing designer creativity. According to the type of designer and according to the practices applied within a precise community of practice, several kinds of object or method are shared. As a result, resources, pedagogical methods and typical situations could constitute an entry point for combining design steps. From this entry point (e.g., typical interactional situations), the designer may perform design tasks alternatively and recursively. Based on these principles, the ISiS model was implemented successively using different types of tool (diagram design or mind mapping software). Our first step involved developing paper forms to express the different dimensions of the design (knowledge context, situational context, intentions, strategies, interactional situations, activities, etc.). We also adapted mind mapping software, in which each node represents a concept (e.g., strategies, phases and interactional situations) and can be edited with a specific electronic form. These initial tools based on the ISiS model were experimented in a secondary school with a group of five teachers of technological subjects. All "teacher-designers" had one month to model a learning sequence, which they then had to implement during the school year using the tools provided. All five teachers accomplished the task they were set within the allotted time. The different sequences produced were between two and six hours long. One teacher actually covered the entire process by (1) describing his scenario in a paper form, (2) encoding the scenario designed with a specific editor (LAMS), (3) automatically implementing the results in Moodle, a learning management system and (4) testing the scenario with his pupils. After these first experiences, teachers were surveyed about their design activity. The answers given by the teacher-designers show the benefits of the model in terms improving the quality of the scenarios created, illustrating the importance of the elicitation of intentions and strategies by users themselves, better understanding the scenarios created by others and simplifying the design process by closing the gap between user requirements and the system effectively implemented.

Lastly, it is important to mention the following points:

- Making explicit the intentions and strategies allowed the teacher-designer to better understand a scenario designed by a peer
- Teachers expressed the need to be provided with reusable components that would allow (a) a significant reduction in the duration of the design process and (b) exploration of the solutions proposed by peers, so as to renew practices
- Full implementation in an LMS by one of the teachers was considered to have been facilitated by using the ISiS model
- The tools provided (paper forms and mind mapping tools) were considered too costly to be incorporated into regular professional use.

These initial results show the ability of the ISiS model to encourage an efficient authoring approach. The main limitation identified by users relates to the provision of suitable graphical tools. To resolve this limitation and after assessment of a number of authoring solutions for learning design (Koper, 2006; Botturi et al., 2006; Dalziel, 2003; Botturi & Stubbs, 2008), we worked with panels of users to co-develop a specific graphical authoring environment named ScenEdit (Emin & al., 2010) and based on the ISiS Model.

Learnelec Pedagogical Scenario

LearnElec (Lejeune et al., 2007) is a collaborative learning scenario stemming from the MATES (Methodology and Tools for Experimentation Scenarios) initiative, which was run by the Kaleidoscope European Network of Excellence. This scenario relates to the “concept of bulb power” in electricity at secondary school level and makes use of the microworld TPElec. The scenario was co-designed by specialists in electricity, didacticians and teachers whose main intention is to dispel a common misconception regarding electricity: “the proximity of the generator has an influence on current intensity”. The idea is to present pupils with an unusual situation where two “visually similar” bulbs in a simple series circuit (simulated using a microworld), do not glow with the same level of brightness. Some students think that electricity wears out when it passes through a bulb. The overall strategy is to organize the class into groups where pupils have to: 1) answer MCQ questions, 2) engage in debate so as to produce a common summary of their answers, which will serve to build the group’s hypothesis, 3) manipulate the TPElec microworld individually and 4) negotiate together to determine the best way of testing their hypothesis. In this scenario, a significant amount of time is spent collaborating in small groups, just like real lab work, through debates and collective drafting of conclusions. To foster collaboration and debate, pupils are given random nicknames (pupil1, pupil2, etc.) when they join the session on the collaborative platform.

Scenedit: A Graphical Authoring Tool for the Design of Learning Scenarios

ScenEdit is a web-based authoring environment that allows a community of teachers to create, modify and reuse learning scenarios. ScenEdit allows teachers to create structured scenarios quickly and easily by:

- Eliciting their intentions, in terms of knowledge, skills and abilities, from a pre-existing database shared by a particular community of teachers
- Choosing scenario patterns that are linked to common or novel strategies and which are well suited to their intentions and to the learning context
- Selecting interactional situations and matching them to the different steps of the strategies
- Managing different components, such as scenarios, intentions, strategies, interactional situations, etc., in specific databases.

In this version, operationalization features have not been yet implemented.

ScenEdit offers three workspaces: the *Scenario editing* workspace, the *Context* workspace and the *ISiS Components* workspace, which are represented by different tabs in the ScenEdit editor.

Figure 2 shows an example of a scenario: LearnElec (Lejeune et al., 2007), implemented with the ScenEdit graphical tool. The Scenario Edition tab (see Figure 2), shows the graphical representation of the scenario with each type of component (Intentions, Strategies and Situations) represented by a different symbol: a triangle for a step, a rectangle for an intention, a rounded rectangle for a strategy, a circle for a phase, and a clapboard or a picture for a situation. The checkboxes (Intentions, Strategies and Situations) in Figure 2 allow the desired levels to be viewed.

Figure 2. ScenEdit main screen

The Scenario editing workspace makes it possible to graphically design a structuring scenario using the whole hierarchy of ISiS levels, by assembling and logically linking elements defined in this tab or previously defined in the ISiS Components tab. The **ISiS Components** workspace is dedicated to managing the three main components of the ISiS model: (a) Intentions, (b) Strategies and (c) interactional Situations. Each component can be made from reusable elements that may already have appeared in a number of scenarios and for each type, the author can either create a new element or import and adapt an existing element from a library. The library contains the scenario's components and all the patterns provided in the global database.

In the LearnElec scenario, the teacher's first learning intention is to dispel a frequently encountered "misconception" held by pupils studying electricity: that "the proximity of the battery has an influence on current intensity".

Figure 3 shows how this intention is implemented within ScenEdit by defining four main elements: the *formulator* of the intention, the *actor involved* by the intention and the intention itself: an *operation* on a *knowledge item*.

Figure 3. An example of an intention in ScenEdit: to "dispel the misconception that the proximity of the battery has an influence on current intensity"

Having defined his intention, the teacher-designer must choose the strategy that will enable the objective to be reached in the most appropriate way. In the LearnElec scenario, the learning intention is implemented through a specific learning strategy known as "scientific investigation", which comprises four phases: hypothesis development, solution development, hypothesis testing and conclusion. This "scientific investigation" strategy can be retrieved from the strategy library where patterns for pedagogical strategies have been defined (e.g.: project-based learning, problem-based learning, role-playing games, etc.) based on a database of literature and the work of practitioners. Figure 4 shows a visual representation of the intention and the strategy we have implemented in four phases.

Figure 4. Example of a strategy in ScenEdit: "scientific investigation"

Each phase can be performed using various pedagogical methods and refined by an additional intention depending on the type of activity the teacher wants to use, the availability of computer services, etc. In our example, the first phase, "hypothesis development", is refined by a learning intention entitled "increase the ability to work in a collaborative way", as shown in Figure 2. This scenario was actually designed on a previous occasion with individual activities, but the educational specialists wanted to transform it in a more collaborative scenario. This intention is implemented with a strategy called "developing a proposal by reaching a consensus" comprising two phases: "Make an individual proposal" and "Compare proposals, obtain a consensus". These replace the previous individual phases, which involved making an individual proposal and then testing it with the microworld.

For each phase, an interactional situation can be defined. Figure 5 shows the form used to define the interactional situation, entitled "Individual proposal using MCQ", in which actors, tools, resources and locations are specified. Finally, during these two phases the teacher is involved in a group management activity symbolized by an interactional situation entitled "Group management", as shown in Figure 2.

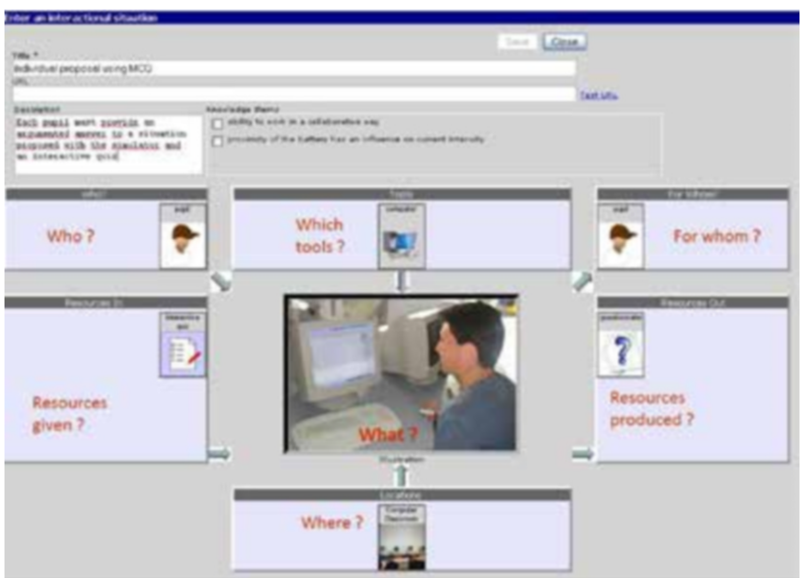

Figure 5. An example of an interactional situation in ScenEdit

The *Context* workspace defines the two types of context in which a learning unit can be executed: the *knowledge context* and the *situational context*. The *knowledge context* tab makes it possible to set out the different knowledge contexts that can be used in the scenario to define the knowledge items used for intentions and pre-requisites. The *situational context* tab makes it possible to define the components

Table 1. Breakdown of the answers to the question regarding re-use for collaborative work between teachers

As regards to collaborative work with other teachers, would you say that the presence of components / patterns.	*Noanswer*	*totally useless*	*quite useless*	*quite useful*	*very useful*	*Total*
.implemented previously by the designers of ScenEdit is.	0	0	0	3	2	5
.implemented previously by other teachers is.	0	0	0	3	2	5
.implemented previously by you is.	0	0	0	3	2	5
Total	0	0	0	9	6	15

Table 2. Breakdown of the answers to the question regarding the usefulness of the suggestions made

Assess the usefulness of the suggestions	*Noanswer*	*totally useless*	*quite useless*	*quite useful*	*very useful*	*Total*
knowledge items	0	0	0	4	1	5
intentions	0	0	0	4	1	5
strategies	0	0	0	4	1	5
interactional situations	0	0	0	3	2	5
Total	0	0	0	15	5	20

of interactional Situations: actors, tools, resources and locations. The choices available for each component depend on the characteristics defined in the Context workspace.

This web version of our graphical editor ScenEdit was piloted by teachers not yet involved in our research, for use in their classes. We briefly describe this experiment in the next section.

TESTING OF THE SCENEDIT ENVIRONMENT

During each phase of this research work (see section 2), experiments were conducted so as to adopt a co-design and user-oriented approach. These experiments with teacher-designers demonstrated the benefits of the ISiS model in terms of (1) improving the quality of the scenarios created, (2) illustrating the importance of user elicitation of intentions and strategies, (3) improving understanding of the scenarios created by others and (4) simplifying the design process by closing the gap between user requirements and the system effectively implemented.

A pilot experiment of our online graphical tool ScenEdit, to determine its usefulness and user friendliness, was conducted in April 2009 over two days in a French secondary school. The subjects were a group of five teachers of Industrial Science and technical subjects (electronics, mechanics and physics). Two of the teachers had worked with us previously to define reusable components within our ScenEdit tool, while the remaining three had never heard of the ISiS model or learning scenario design before this experiment. This qualitative study has helped us to improve the model and the tools we have been developing. Here we will only present the main results, and primarily those relating to the advantages and possibility of reusing components (Intentions, Strategies, interactional Situations) or scenarios in the form of templates or design patterns. Table 1 shows their answers to questions on collaborative work with other teachers. More specifically, the elements provided in ScenEdit (knowledge items, intentions, strategies, interactional situation patterns, etc.) were unanimously deemed useful, as can be seen in table 2.

In answer to the question "*Would you say that the presence of components and patterns is…*" (two possible choices), the main terms used were "an advantage" (4 answers) and "helpful" (4 answers). One of the teachers involved in the experiment said it was both an "advantage" and a "constraint", explaining that "at first sight I found the choice was not sufficiently wide, I was a little frustrated that I couldn't put whatever I wanted… and lastly, another advantage of ISiS is that it allows you to think of words that everybody can accept, so that we all speak the same language". This demonstrates that he was convinced of the need for the list to contain a definite number of possibilities, as long as the vocabulary chosen is relevant to users.

Some of the comments suggested improvements to the visual representation of the ISiS model. In particular, greater precision is required in covering the temporal dimension, which is not represented in the current simple tree version. Moreover, the teachers involved pointed out that making the phases and activities more explicit was helpful to them, because "the scenario can be understood and used more quickly".

Ultimately, a detailed analysis of this qualitative study (Emin et al., 2009) demonstrates that having access to components that are reusable in a design context is useful even for a teacher's day-to-day classroom work or for collaborative work with other teachers.

CONCLUSION

In this chapter, we presented an overview of the ISiS model and the ScenEdit authoring environment, the purpose of which is to assist teachers in designing learning scenarios and to favour sharing and re-use practices. According to our experiments, the ISiS model, which was co-developed with a panel of practitioners, appears to be effective. Part of our work with the teachers involved formalizing and designing patterns for learning scenarios, pedagogical approaches and recurring interactional situations. ScenEdit offers several patterns of different levels (intentions, strategies and interactional situations) developed on the basis of the best practices found in the literature and within communities of practice. With this environment, we expect users to be able to populate databases by exporting fragments of their own scenarios, so as to share these scenarios with others or reuse them in related or unrelated contexts. The graphical representation provided in Figure 2 is a standard hierarchical tree. This is quite useful for scenario production but not very clear when it comes to understanding a new scenario, because of the different levels of imbrication. The new graphical representation we wish to implement is a tree in which the horizontal dimension represents the passing of time, while the vertical dimension represents the hierarchy of ISiS concepts. Since the scenario can be encoded as an XML file, different outputs can be produced, meaning that a printable text or form is now available to teachers. We plan to offer several conversion possibilities in a future version: a printable picture of the editing views and a SCORM package that can be executed in an LMS.

Our aim is to experiment ScenEdit more thoroughly, with a wider audience who is not necessarily very familiar with ICT, scenario design software or the methods in question.

NOTE

[1] Institut National de la Recherche Pédagogique (French National Institute for Research in Education), which in 2012 became the IFE, Institut Français d'Education (French Institute of Education)

REFERENCES

Booch G., Jacobson I., & Rumbaugh J. (2004). *UML 2.0 Guide de référence* (p. 774). Campus Press.

Botturi, L., Cantoni, L., Lepori, B., & Tardini, S. (2006). Fast prototyping as a communication catalyst for e-learning design. In M. Bullen & D. Janes (Eds.), *Making the transition to e-learning: Strategies and issues.* Hershey, PA: Idea Group.

Botturi, L., & Stubbs, S. (2008). *Handbook of visual languages in instructional design: Theories and pratices*. Hershey, PA, USA: Informing Science Reference.

Dalziel, J. (2003). *Implementing learning design: The Learning Activity Management System (LAMS)*. Proceedings of the ASCILITE 2003 conference, Adelaide.

Derntl, M., & Motschnig-Pitrik, R. (2005). The role of structure, patterns, and people in blended learning. *The Internet and Higher Education*, *8* (2), 111–130.

Derntl, M., Neumann, S., & Oberhuemer, P. (2011). Community Support for Authoring, Sharing, and Reusing Instructional Models: The Open Graphical Learning Modeler (OpenGLM). Proceedings of IEEE ICALT 2011, Athens, Georgia, USA.

Dimitriadis, Y., Goodyear, P., & Retalis, S. (Eds.), (2009). Using e-learning design patterns to augment learners' experiences. *Computers in Human Behavior*, *25*(5), 997–1188.

Emin V., Pernin J. P., & Aguirre J. L. (2010). ScenEdit: An intention-oriented authoring environment to design learning scenarios. In M. Wolpers, P. Kirschner, M. Scheffel, S. Lindstaedt, & V. Dimitrova (Eds.), *Sustaining TEL: From innovation to learning and practice, vol. 6383 of lecture notes in computer science* (pp. 626–631). Berlin & Heidelberg: Springer.

Emin, V., Pernin, J. P., & Guéraud, V. (2009). Model and tool to clarify intentions and strategies in learning scenarios design. In U. Cress, V. Dimitrova, M. U. Specht, V. Cress, Dimitrova, & M. Specht (Eds.), *Learning in the synergy of multiple disciplines. vol. 5794 of lecture notes in computer science* (pp. 462–476). Berlin & Heidelberg: Springer.

Goodyear, P., Avgeriou, P., Baggetun, R., Bartoluzzi, S., Retalis, S., Ronteltap, F., & Rusman, E. (2004). Towards a pattern language for networked learning. *Proceedings networked learning conference 2004*. England, UK: Lancaster University.

Hernández-Leo, D., Villasclaras-Fernández, E. D., Asensio-Pérez, J. I., Dimitriadis, Y., Jorrín-Abellán, I. M., Ruiz-Requies, I., & Rubia-Avi, B. (2006). COLLAGE: A collaborative learning design editor based on patterns. *Educational Technology & Society, 9* (1), 58–71.

Koper, R. (2006). Current research in learning design. *Educational Technology & Society*, *9*(1), 13–22.

Koper, R., & Tattersall, C. (2005). *Learning design: A handbook on modelling and delivering networked education and training*. Heidelberg, Germany: Springer-Verlag.

Laurillard, D., & Ljubojevic, D. (2011). Evaluating learning designs through the formal representation of pedagogical patterns. In C. Kohls & J. Wedekind (Eds.), *Investigations of e-learning patterns: Context factors, problems and solutions*. Hershey, PA: IGI Global.

Lejeune, A., David, J. P., Martel, C., Michelet, S., & Vezian, N. (2007). *To set up pedagogical experiments in a virtual lab: Methodology and first results*. Villach, Austria: International Conference ICL.

Lundgren-Cayrol, K., Marino, O., Paquette, G., Léonard, M, & de la Teja, I. (2006). Implementation and deployment process of IMS learning design: Findings from the Canadian IDLD research project. *Proceedings Conference IEEE ICALT'06* (pp. 581–585).

Mor Y., & Winters, N. (2007). Design approaches in technology-enhanced learning. *Interactive Learning Environments*, *15*(1), 61–75. ISSN 1744–5191.

Murray, T., & Blessing, S. (2003). Authoring tools for advanced technology learning environment, toward cost-effective adaptive. In S. Ainsworth (Ed.), *Interactive and intelligent educational software* (p. 571). Dordrecht, The Netherlands: Kluwer Academic Publishers.

Rolland, C., Prakash, N., & Benjamen, A. (1999). A multi-model view of process modelling. *Requirements Engineering*, *4*(4), 169–187.

Schank, R. C., & Abelson, R. (1977). *Scripts, plans, goals and understanding*, Hillsdale, US: Erlbaum.

van Lamsweerde, A. (2001, August). *Goal-oriented requirements engineering: A guided tour*. 5th IEEE International Symposium on Requirements Engineering (RE'01) (pp. 249–263), Toronto, Canada.

WEB-REFERENCES FOR THE DEMONSTRATION

ScenEdit Home Page
http://eductice.ens-lyon.fr/EducTice/recherche/scenario/scenedit
Remote access to the Prototype
http://scenedit.imag.fr/demo/
login: demo_scenedit

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