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1. LEARNING, TECHNOLOGY AND DESIGN

INTRODUCTION

This chapter provides an orientation to the key themes of the book, as well as an overview of the individual contributions. We introduce and develop a number of ideas that underpin the coherence of the collection. Learning is, of course, at the centre of our concerns – supporting other people's learning is the point of our enterprise. But we approach this indirectly. The book itself is about how people who are professionally engaged in supporting other people's learning can share their experiences. To bring extra focus to the book, we are specially concerned with situations in which technology is also being used to help people learn. The umbrella term we are using for this is 'technology-enhanced learning' or TEL, but other terms, such as computer-assisted instruction (CAI), computer-aided learning (CAL), networked/online learning and e-learning carry similar connotations. Using technology to help other people learn is complex. It needs to be approached in a planful spirit. That is why we speak of design. Indeed, the essence of the book is about how to help people share TEL design ideas and experiences. It is a book for people engaged in the practical work of TEL design, but also for those who want to help such people collectively improve what they do. This may seem a rarefied position – at several removes from the student experience – but this also gives the work a multiplier effect. Its benefits are amplified by the activities of those who help teachers and other educational designers do a better job for the many learners they, in turn, support.

We will spend some time introducing a number of ideas. Some of these, like learning, can seem quite familiar. But they need careful handling, because of the slipperiness of everyday usage. We also have some less obvious themes to develop, such as the need to be able to see deep continuities beneath the surface of change. TEL may look as if it is born anew every few years – such that some people claim there is no possibility of accumulating relevant design experience – whereas the practiced eye can see beneath the wrappings.

LEARNING AND DEEP CHANGE

In turbulent times success, and sometimes survival, depend upon the ability to distinguish between what is changing and what is staying the same. Adaptation is not enough. Indeed, adaptation in response to the surface features of change –

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attending to symptoms rather than causes – can be fatal. Human beings have demonstrated an extraordinary capacity to survive and succeed by adapting to changing circumstances, abandoning established practices while also avoiding new perils and taking advantage of new opportunities.

Learning and adaptation are closely linked. Some of the oldest, most deeply-rooted and most powerful methods of human learning – through observation, imitation and participation – work best when what must be learned is directly available to the senses. A child's learning of its native language(s) and the pre-linguistic sharing of tool-making skills are good examples (Hutto, 2008.) But what happens when survival depends upon understanding *deep* change rather than merely adapting to that which is readily apparent to the senses? Roughly speaking, humankind now has two strategies. One is based on language, abstract thought and the ability to deal with complex conceptual systems. It involves the creation and manipulation of symbolic representations of the world: it underpins much of science. The other uses information and communication technologies (ICT) to render visible – more broadly, to make available to the senses – that which would otherwise be abstract or hidden. Of course, these two strategies are often combined, as when scientists use visualisation techniques to understand the structure of complex molecules or the cosmos. In formal education – by which we mean much of what happens in schools, colleges and universities – there has, for a century or so, been a strong emphasis on abstract thought and complex symbol systems. This has produced a small cadre of competent scientists but has signally failed to equip the majority of us to help make decisions on issues of national and global importance. In short, most people find the acquisition of complex conceptual knowledge hard. We find ourselves trying to reason about and discuss macroeconomics or climate change using domestic analogies and anecdotal evidence. Much of the public discourse of politicians, journalists and pundits is stuck in the same mire. One of the great challenges for those who work in educational technology and the learning sciences is to create tools and resources – or powerful learning environments – that help everyone use their innate learning abilities to come to understand things which are not otherwise directly available to the senses.

Learning is often hard, but it's never been more important. It is key to prosperity for individual people, for the firms or other organisations in which they work, for the competitiveness of national economies, and – it would now seem – for global stability and survival. Technology, especially ICT, has been part of the complicated network of processes involved in the globalisation of work, ideas, capital and risk (Lash & Urry, 1994; Urry, 2003; Castells, 1996; 2006). It has allowed banks to spread toxic debt just as it also allows monitoring of carbon emissions and modelling of climate change. It *can* play a role in helping people, as individuals or in community groups, companies or governments, take knowledgeable action. It can do this in a variety of ways. The last few years have seen enthusiastic take-up of so-called Web 2.0 technologies – including social networking technologies that can empower community action groups and strengthen political parties. We have already alluded to ways in which visualisation technologies can render abstract ideas concrete and manipulable. There have also been trends to embed ICT in domestic and working environments – captured in ideas like 'ubiquitous computing', 'ambient intelligence', 'wearable computers' and even 'the disappearing computer' (Bell & Dourish, 2007). ICT is finding niches in formal education: not just laptops for students but interactive whiteboards, digital libraries, e-portfolios, learning management systems, simulations, videoconferencing, virtual laboratories, programmable and location-aware devices. As Seymour Papert cautioned, 30 years ago, it is tempting but dangerous to imagine that our recent experiences of ICT are a reliable guide to what ICT will be like in the future – even the near future (Papert, 1980). The pace of ICT innovation is not slackening and we are witnessing an accelerating interpenetration of the digital and material worlds: such that it will become hard to see where one stops and the other begins (Mitchell, 1995).

This has profound implications for the work of anyone who is professionally involved in helping other people learn. Bluntly put, it would be a profound mistake to imagine the skillset they will require by projecting current manifestations of educational technology more than a few years into the future. We need a more radical and holistic imagination. We also need to distinguish between enduring fundamentals of learning and teaching and the transient froth splashed up by each new wave of innovation.

Learning – as we will see in a moment – can be implicit, informal and formal. Technology can enhance all three kinds of learning, as well as their combination. Technology can be used to tighten *or* slacken the bonds between perceiving, learning, knowing and action. It can provide scaffolding for our unsteady attempts at tackling new problems. It can be designed into artefacts to shape our behaviours in ways that we only subsequently come to understand and endorse, or reject. Once one acknowledges the rich and growing set of possibilities for connecting technology, minds and action, old definitions of the scope of 'educational technology' and 'instructional design' look peculiar and quaint.

This brings us to one of the major problems that have to be tackled by anyone producing a book about TEL design. It must be future-oriented without being futuristic. It must be underpinned by a conception of the scope and practices of design that will not seem dated within a couple of years. It cannot be obsessed by the tools and assumptions of the moment. It needs to be informed by a sense of the trajectory and pace of change, but not be captured by wishful thinking or technological romanticism. In bringing this collection together, as well as in collaborating in some of the research reported in the book, we are making a clear commitment to a set of ideas about TEL design. We go into these in more detail below, but included among them are beliefs that: education needs to become more design-savvy if it is to improve outcomes for the majority of learners; TEL design is a job for teams of people, rather than for lone individuals; TEL design is hard, takes time and needs experience, but TEL design experience *can* be shared. This book arises from a conviction that design patterns and pattern languages are worth serious exploration as candidates for sharing TEL design experience. To convince you of that, we will need to say something about what the patterns-based approach entails.

THE PATTERNS APPROACH TO SHARING DESIGN EXPERIENCE

At their simplest, design patterns encode design experience by pairing a *problem* statement and a *solution*. The problem:solution pairing is almost always set within some larger *context*, and the solution is expressed in a way that leaves details to be worked out, or *embellished* by other, lower-level patterns. Most important, the text of the pattern also includes a *rationale* (drawing on research, theory, experience, etc). Patterns can be connected in sequences, known as pattern languages. We realise this description is rather abstract and will provide some concrete examples shortly.

Notions of sharing and re-using TEL designs have been around for some time (see e.g. Pirolli, 1991; Goodyear, 1994; Koper & Tattersall, 2005). The goals and assumptions of the work in this area have been quite varied. *Our* commitment to the task of developing and testing patterns and pattern languages for TEL depends on a distinctive combination of goals and assumptions. In particular, we see the patterns-based approach as offering a way of capturing design experience that:

1. Connects recognisable problems with tested solutions
2. Relates to design problems at any scale level (micro, meso, macro, etc), and connects design solutions across scale levels
3. Can be supplemented with research-based evidence
4. Balances guidance with creativity
5. Has wide application but is customisable to meet specific needs
6. Can improve design performance while also educating the designer.

An advantage of using TEL design patterns, especially when combined into pattern languages, is that they have the flexibility to cover the broad and expanding space of TEL design challenges we sketched above. This is because the same *kind* of pattern can be used to represent design experience that refers to quite heterogeneous design components – learning tasks, digital resources, material spaces, composition of learning groups, etc – and that refers to the integration of design components at various scale levels (e.g. to improve the alignment between the requirements of a learning activity and the affordances of the nested physical and digital spaces in which it is set). These claims will be easier for us to explain, and for you to assess, when we have said more about the nature of design patterns and pattern languages (below).

Another element we need to introduce into the mix is the matter of values. It *is* possible to approach instructional/educational design as if it were a value-free zone – a space for the exercise of value-neutral technical expertise. We disagree with this notion. Value-neutrality is talked about, within the TEL field, in a number of ways. Some will argue that technology itself is neutral – it can be *used* in good and bad ways. Some will talk about the 'pedagogical neutrality' of technologies or designs – implying that such neutrality is virtuous, in that it extends an invitation to educators of all persuasions: creating an open church. We are not convinced, but don't want to spend time here engaging in a futile argument about naïve conceptions of neutrality. Quite the opposite. Part of what attracts us to the world of design patterns is that many pattern-hatchers have a strong sense of the need to search for what is *good*. This goes back to the original work of Christopher

Alexander, whose concern for patterns in built space was rooted in a quest to understand what makes spaces *live*; what imbues them with the qualities that make us feel most alive and complete. This may seem an overblown conceit when applied to TEL. Again, we disagree – but the proof of the pudding is in the eating.

PURPOSE OF, AND AUDIENCE FOR, THIS BOOK

We have produced this book in the hope that it will be both a landmark and a signpost. It represents the maturing of a specialist field still occupied by only a few hundred people. The earliest work on pedagogical design patterns dates back to 1996 (Sharp et al., 2003). Take-up of this work in the TEL field began a year or so later (see Lyardet et al., 1998). A number of researchers around the world began independently exploring the possibilities of TEL design patterns and pattern languages: the fruits of some of this work is summarised in chapters of this book. In addition, a collaborative exploration of the area gathered momentum in the period 2002 to 2005, with the help of European Union funding for the ELEN and TELL projects, both of which were directed by Symeon Retalis and involved Peter Goodyear. Other chapters in the book have been written by people who collaborated in one or both of these projects. In this sense, the book is a milestone – it marks progress to a worthwhile viewpoint. But we hope that it will come to be seen as just the first major marker on what turns out to be a long journey, involving many more people – not just researchers but also design practitioners and those who educate and mentor designers, and who sponsor good design. Each chapter reviews work done, but also, implicitly or explicitly, suggests new roads to be travelled. We have chosen the chapters as much for what they suggest and inspire as for the accomplishments that they document. In addition, we have provided a closing chapter which also identifies some important open questions and recommends some promising lines for further R&D work.

It will be clear that our primary audience is the community of people who are seriously involved in TEL R&D. This is not just a book for academic researchers; it is also meant to be of value to people whose innovative spirit finds expression in creating new tools and systems. There are tensions and synergies in the work of research and development – rather like the tensions and synergies between experimental and theoretical physics. We hope that this book will help people advance on both fronts.

We have not assumed that teachers in formal education – whether at school or tertiary level – will provide a natural audience for the book. We hope that it *will* have a detectable effect on educational practice, but that effect is likely to be mediated by the R&D community and by those who write directly for, and teach, TEL designers.

We now turn to a concise but necessary discussion of some of the key elements we sketched above, in order to set the stage for the chapters which follow. We need to say a little more about: learning, technology-enhanced learning, design, the sharing and reuse of designs, design patterns and pattern languages, and the question of value.

LEARNING

Learning is conventionally defined as the process of acquiring competence and understanding. It results in a new ability to do something, and/or an understanding of something that was previously not understood. Competence is sometimes described in terms of possessing specific skills; understanding in terms of possessing specific knowledge. Some accounts also talk of attitudes: learnable predispositions to act in specific ways. From the 40s to the 70s, it was common to speak about learning by referring only to observable behaviours – such that learning was described as a process through which experience brought about lasting changes in behaviour. Since the 70s, it has become respectable to talk about inferred (rather than directly observable) mental structures and processes – for example, to talk about learning as a process which results in changes to long-term memory. Researchers in the learning sciences have assembled a substantial array of theoretical constructs with which to describe processes of learning and knowing, including taxonomies of types of knowledge (e.g. declarative, procedural, strategic, situational; implicit and explicit; general and domain-specific, etc). Within this scientific tradition, there is a strong consensus that different kinds of knowledge are acquired in different ways: e.g. facts are best learned through clear exposition, activation of prior knowledge and repeated exposure; skills are best learned by observation and then practice with feedback; complex declarative knowledge is best learned through participation in discourse, etc (see e.g. Ohlsson, 1995; Chi & Ohlsson, 2005).

A good deal of research and development work in the overlapping fields of educational technology and the learning sciences has been motivated by a belief that formal education is failing to meet the needs of individuals and society. Its failings can be seen in (i) the weaker performance of students from poorer families (i.e. education is reproducing inequalities) and (ii) the fact that much of what students learn turns out to be inert, fragmented knowledge. It is fit for recall and reproduction in time-limited exams, but it is not much use for solving problems outside the exam hall (Renkl et al., 1996).

In diagnosing and starting to act upon these weaknesses, recent research has:

1. Looked more closely at the character and constituent elements of real-world expertise, delineating the differences between novice and expert in many different domains of practice, and showing how experts see problems differently from novices, draw on a solid foundation of experiential knowledge, and are able to continually learn, deepen and broaden their knowledge base, improvise and experiment – their expertise is *adaptive* (Alexander, 2003; Ericsson et al., 2006). Unless we have a clear idea of what experts actually do, and how they do it, we cannot point novices in the right direction.
2. Examined learning and action from a *situative* perspective – moving beyond what a lone individual might be said to know, or be able to do, to consider activity systems (see e.g. Greeno, 2006). In Greeno's words, activity systems are "complex social organisations containing learners, teachers, curriculum materials, software tools and the physical environment" (op. cit., p79). In design terms, the situative view focuses attention on "characteristics of activity systems that can result in

learners increasing their capabilities for participation in ways that are valued" (op. cit., p80). Learning comes to be understood as both an individual cognitive accomplishment and the ability to engage effectively in a valued social practice, appropriating the symbolic and material tools of a culture (Saljo, 1999).
3. Taken seriously the idea of knowledge work and *learning to think for a living* (Davenport, 2005; Goodyear & Ellis, 2007). This has been pursued in a number of ways, but most significantly through giving students authentic opportunities to engage in 'knowledge building' – working with others on the improvement of ideas (Bereiter, 2002).
4. Combined ideas about activity systems and knowledge building to test and experiment with conceptions of learning in communities of inquiry; or locating learning as apprenticeship in a community of practice (Wenger, 1998).
5. Begun to recognise that learning is influenced by, and needs to be understood in terms of, phenomena that come to bear at a number of scale levels – from 'neurones to neighborhoods' (National Research Council, 2000). This includes a recognition that some learning processes – which can be labelled *implicit* learning – seem to align particularly well with the capabilities of the human brain. "Implicit learning refers to situations in which complex information is acquired effortlessly… and the resulting knowledge is difficult to express verbally…Implicit learning has educational and even evolutionary value inasmuch as it enables organisms to adapt to new environments by listening, observing and interacting with the objects and people encountered there, even in the absence of formal pedagogy or a conscious effort to learn" (Bransford et al., 2006, p19-20). Hutto (2008) argues that implicit learning can account for many basic human accomplishments, including pre-linguistic use of tools. Implicit learning is being studied from a cognitive neuroscience perspective. Some commentators see this as a distraction from research on informal learning (as studied by anthropologists) and formal learning (as studied by educational researchers). We join Bransford and colleagues in suggesting that powerful new insights into learning are likely to emerge from studying novel combinations of implicit, informal and formal learning. TEL has a particularly strong contribution to make, insofar as it can be used to create environments within which complex abstract ideas can be rendered perceptible to, and manipulable by, the powerful processes implicated in implicit learning.

Clearly, learning has to be understood in terms of a complex set of phenomena, entailing multiple processes and agents. TEL design cannot subscribe to the folk psychological view that sees teaching and learning as merely the transmission and reception of information.

That said, we also think it is useful to distinguish between *learning* – which we take as a label for a set of embodied psychological processes which lead to greater competence or understanding – and *studying* – which is a useful descriptor for a set of real-world activities in which people engage, for the purposes of intentional learning. As well as such psychological processes as problem-solving, reflection and mental rehearsal, studying includes activity in the real world. It includes such things as searching for information on the WWW, browsing library shelves, talking to other students or teachers, finding one's lecture notes, writing essays or project reports, planning a revision schedule, and so on. This is worth saying, because educational design needs to support study activities – a student's work in the world – not just the inner psychological processes of learning (Goodyear, 2000).

TECHNOLOGY-ENHANCED LEARNING

TEL is proving an attractive term because it is open to a very broad range of interpretations – it is not restrictive with respect to either types of technology or pedagogical approaches. We use it to cover all those circumstances where technology plays a significant role in making learning more effective, efficient or enjoyable.

Many different types of technology can be used to support and enhance learning. "Technology" in its broadest sense can include both *hardware* – such as interactive whiteboards, smart tables, handheld technologies, tangible objects – and *software* – e.g. computer-supported collaborative learning systems, learning management systems, simulation modeling tools, online repositories of learning content and scientific data, educational games, web 2.0 social applications, 3D virtual reality, etc.

In terms of hardware, technology continues to change dramatically. The cost of hardware has decreased significantly while its raw performance has improved exponentially. Typical examples of this trend are the technically brilliant and innovative small machines like MIT's OLPC (OneLaptopPerChild) or Intel's classmate PCs, which have appeared as missionaries of educational change in developing countries. In addition to PCs, schools and other organisation have been investing in what might be called 'smart furniture'. Interactive whiteboards are one example, but designers are also adding intelligence to classroom furniture in other ways – such as in smart tables that indicate who, in a group, is doing most of the talking (see BECTA, 2006; Bachour et al., 2008).

In addition to "traditional" desktop computing, where learners reach into a digital educational world via the screen, nowadays electronically embedded physical artifacts or tangible devices enable new types of learner interaction, i.e. full body, haptic, and spatial (Fishkin, 2004). Designing tangible interfaces requires not only designing the digital but also the physical space, and their interrelations within hybrid ensembles that can facilitate individual and social interaction. An example of the use of tangible interfaces for collaborative learning in and outside the classroom is the KidStory project, which aimed to develop technology to support children's group storytelling activities using various tools such as crayons and paintbrushes anywhere on an infinite 2D drawing surface (Stanton et al., 2001).

Also, software technology is changing and is becoming more net-based. As a result, new uses of software technology are emerging. These can enhance student learning, prepare students for effective technology usage in their prospective workplace and/or enable staff to be more productive (Chickering & Ehrmann, 1996).

Thus, designers are investigating what characteristics make technologies effective vehicles for education (Becker, 1994). The key word is "affordances". Technology affords a range of opportunities that can transform the learning process, offering enhanced possibilities for knowledge and skills acquisition. It does not determine or control.

Several taxonomies of technologies for learning have been proposed (Bruce & Levin 1997; Jonassen, 2000; Chickering & Ehrmann, 1996; Conole et al., 2004). For example, we can think of tools and systems for reading, thinking, communicating, and acting in the world:

– *Technologies as media for accessing and studying learning material.* Software systems like Learning Management Systems (e.g. Blackboard, Moodle) or Learning Objects Repositories (e.g. MERLOT) are being widely used for the dissemination/ acquisition of educational material in various formats.

– *Technologies as media for learning through inquiry.* One example is the WISE learning environment, which has been developed in Berkeley, where learners examine real world case studies and analyse current scientific controversies (http:// wise.berkeley.edu/). STOCHASMOS is a web-based learning environment developed at the University of Cyprus, which allows learners to investigate, organise and interpret complex and diverse scientific data and phenomena (http://www.stochasmos.org). Of course, simulation environments like STELLA, Stagecast Creator, Cabri, have been effectively used in learning environments.

– *Technologies as media for learning through communication and collaboration.* Several computer-supported collaborative learning (CSCL) systems, such as CENTRA, DimDim, Synergeia, CoolModes, have been developed to facilitate synchronous and asynchronous collaborative learning tasks. Nowadays, wikis, blogs as well as 3D shared worlds like Secondlife, ActiveWorlds are being extensively used in learning scenarios for various courses (Alexander, 2006).

– *Technologies as media for learning through construction.* Various software tools have been developed for enabling learning by doing. Typical examples are lego-like logo robots (Turner, 2006). Learners build robots out of LEGO pieces, using not only the traditional LEGO building bricks but pieces like gears, motors, and sensors. They also build complex computer programs by "snapping together" Logo commands thus adding behaviour to the LEGO.

– *Technologies for learners' assessment.* Several freeware and commercial self-assessment tools (e.g. HotPotatos, Question Mark Perception) have been designed for assessing learners' knowledge. Nowadays, there is a tendency to build tools that allow new methods of evaluations such as Electronic Portfolios which offer capabilities for storing, displaying and reviewing/grading learners' work in a variety of formats (Meyer & Latham, 2008).

– *Technologies for digital and multimedia literacy.* Various tools have been designed for supporting learning through expression using multimedia such as tools for video editing and annotating, image processing, web comics creation, and so on (Goodman, 2003; Gutierres Martin, 2003).

The role of technology is to direct, foster thinking and facilitate the acquisition of higher order skills. The challenge is to creatively use technologies by focusing upon their affordances. In a well designed technology-enhanced learning environment learners will engage in the process of manipulating information and critical thinking as well as expressing and sharing their knowledge to peer-learners.

DESIGN

We use the term 'educational design' to mean the set of practices involved in constructing representations of how people should be helped to learn in specific circumstances.

In formal education, a central role tends to be given to 'the teacher'. Teaching is a hybrid activity, which typically involves a mix of advance planning, interactive teaching, giving feedback on students' work and reflection. Popular images of teaching foreground its interactive aspects – the teacher is seen as a person who orchestrates activity in a classroom, provides explanations of ideas and techniques – sometimes at considerable length – and, when time allows, engages in individual conversations to help solve students' problems (Calderhead, 1984; Bligh, 2000; Davis, 2004). While all these aspects of the role are important, we detect a shift in emphasis – one that mirrors a shift in the sense of what students ought to be doing to learn most effectively.

In short, as images of 'good learning' resolve around the centrality of what learners *do* – on the quality of their mental activity – so, images of teaching resolve around the design of good learning tasks, and the design and management of supportive learning environments. The emphasis shifts from teaching-as-exposition and teaching-as-interaction to teaching-as-design. This can be seen in the work of teachers at all levels – school to university – and is proceeding most rapidly in situations where students are engaged in various forms of inquiry-based learning (Levy et al., 2009). Here, for example, the teacher's main work involves setting productive, appropriately challenging inquiry tasks, ensuring that students have the tools and resources they need to make a success of each task (including opportunities for group activity), and then discretely monitoring progress. This strand of teachers' work has to be planful – ideas about good tasks have to be thought through carefully; care has to be taken over identifying and setting in place the necessary tools and resources, and over helping students organise their work – individually, in small groups or teams, or as some kind of learning community. We see 'teaching-as-design' as an important but rather neglected, even shadowy, kind of educational work. It is recognised in some parts: course and curriculum design and the design of reliable, valid assessment tasks have long been on the teaching agenda. But they are rarely seen as part of the day-to-day work – they are more for specialists in assessment or senior curriculum leaders, and they happen relatively infrequently. We use the term 'teaching-as-design' to draw attention to the regular designerly work involved in teaching – it is growing in frequency and importance, but is not yet properly supported, with time or tools or intellectual resources (Fink, 2003).

Teachers are not the only people who engage in educational design. Within school systems, one finds specialist staff involved in creating new learning resources, as well as reshaping courses and curricula. With the widespread take-up of ICT, many school systems have a cadre of staff involved in technical support but also in helping customise ICT for local educational purposes. In universities and colleges, as well as in corporate training, there is a well-established profession of instructional design – involving specialist staff who advise teachers and teaching teams, and collaborate in various combinations to help produce learning tools and learning resources. At the university level, in particular, the acquisition of enterprise-level learning management systems (also known as virtual learning environments), such as Blackboard and Moodle, has generated a need for specialists with instructional design and ICT skills to help mainstream teachers make effective use of the LMS investment (Keppell, 2007).

We are drawing attention to two related shifts in mainstream educational practice. A shift towards ideas about good education that are centered on the quality of the learner's activity is intersecting with a trend towards greater use of ICT. The combination – activity-centered TEL – creates a growing demand for good educational design.

A robust, contemporary conception of educational design needs to recognise that: (a) good design is complex and takes skill, experience and time, (b) it includes the design of good learning tasks, but also the design of supportive, convivial learning environments, (c) design works indirectly: learners have scope to adapt, customise and invent, (d) it operates at various scale levels – from the detailed functionality of a tool or the interface to an e-book right up to the institution-wide infrastructure. Vertically coherent educational design is needed to ensure that what learners need to do – at a micro level – aligns with the nested set of learning spaces in which their activity is set. (This is a crucial point. It is very hard, in complex educational institutions such as universities, to establish a shared understanding of the interactions between pedagogy and infrastructure at all the key levels in the decision-making hierarchy. Crudely put, it is a rare director of property services who understands the psychology of learning, or what this implies for the affordances of built space.)

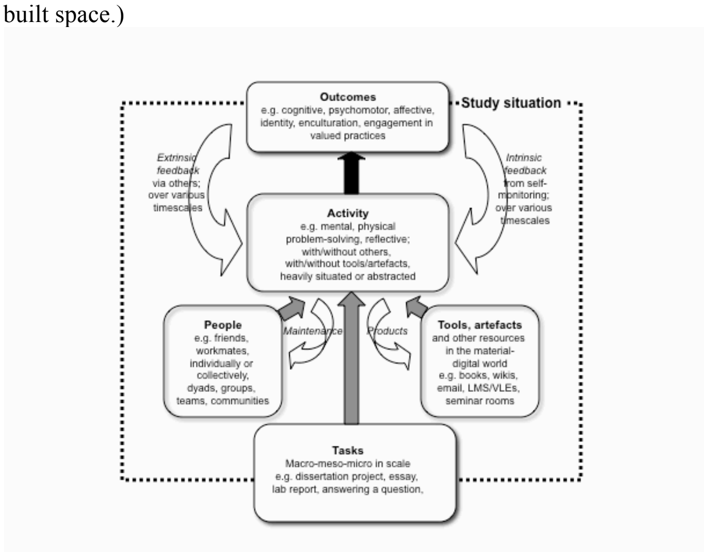

Figure 1. The problem space of educational design.

Figure 1 helps capture what we mean by the problem space of contemporary educational design. It is an elaboration of the model in Goodyear (2005). The model gives a central place to student activity – to the mix of psychological and physical activity through which each student responds to their current task. Earlier in the chapter, we distinguished between study and learning. We place study activity at the centre; learning processes are tightly bound up within the activity, but are not the same as the activity. Learning and its outcomes are – from a functional educational perspective – the things that matter. Productive activity enables valued learning.

Productive activity does not take place in a vacuum. The physical and social situation in which it is set can play a subtle but decisive role in shaping activity and its outcomes (Greeno, 2006). Of course, one can think – for a while – without noticing the intrusion of the physical world or other people. But this is rare. Much of what we do involves interaction with the physical world and/or other people. This may be as simple as doodling, jotting down keywords, flipping through the index of a book, or Googling a definition. It may be no more than an exchange of grunts with a team mate, as you notice a snag in what you thought was a solution. But the constraints and affordances of the physical and social world can be *very* influential in shaping activity – limiting access to useful information (or bombarding the senses); providing opportunities for debate, that reveal the rich variety of other people's beliefs; giving a sense of being a useful, if peripheral, member of a global intellectual community, and so on. For these reasons, *Figure 1* insists that design has three main components: the design of good learning tasks (which stimulate and help structure, but do not wholly determine the students' activity), and design of the physical and social context(s) for students' activity.

We said that educational design is best understood as an *indirect* practice. It does not directly create activity. Rather, it creates good learning tasks – as blueprints for activity. It identifies useful tools and resources, and has things to say about necessary infrastructure, but it leaves the detail of configuring the learnplace to the student. In the same vein, it can – and often should – make recommendations about how students should work with others (in pairs, in teams, as a community of inquiry, on their own; with similarly able students, or in mixed ability groups, etc). But students also make their own decisions about who to work with, and how. They co-configure the social and physical context; they adapt learning tasks to meet their needs. They co-create the activity systems.

Design takes time. Even if one simplifies the challenges and opportunities sketched above, design remains a demanding task. It is characterised by various kinds of experimental thinking – some would say trial and error. It involves imagining other people's learning: how they will respond to a task, where they will work, with whom, how, using what resources, over what timescale, and so on. There are echoes of the architect's imagination – how will people respond to a new built space; how will their activity settle within it; will it make them happier, more stressed, able to focus or subject to distraction? Design is iterative. It rarely 'comes right' at the first attempt. It involves 'wicked' rather than well-formed problems (Kirschner et al, 2002; Ertmer et al., 2008; Jonassen, 2008). Because it is cognitively demanding, design usually needs tools and external representations – designers need to 'offload' parts of the problem by committing partial solutions, promising ideas, etc to paper, or screen (see e.g. Schon, 1983, Ch3; Bell, 1999; de Vries & de Jong, 1999; Michell, 2003; Buxton, 2007). It's especially hard for the lone teacher to do good design work. Designs are improved through talk and reflection, criticism and explanation (Levy et al., 2009). Design works best in teams, to which people bring a range of complementary skills and knowledge.

All of this raises questions about whether and how educational design activity can be improved. We are convinced that it *can* be improved, and that the patterns-based approach has remarkable potential for supporting such improvements. The iterative, demanding, time-consuming nature of design means that it is possible to imagine such things as design guidelines, knowledge and experience being used (embodied in books, tools, automated aids, etc) – in a way that is unimaginable if we are thinking about live/interactive classroom teaching. Part of what attracts us to the use of design patterns is their potential *fit* with the cognitive demands and processes of real-world design activity. As we will try to show, they are both action-oriented and educative: they provide scaffolding for decision-making when the designer needs such help, but they also teach more general lessons (Goodyear & Yang, 2009). Also, as we will see, the possibility of combining patterns in pattern languages that traverse micro to macro scale design issues, means that they can be used to align the design and other decision-making work of people who have responsibility for the management of learning environments at all scale levels, and across virtual and material spaces.

On the downside, we would have to acknowledge that educational design, as typically practiced in formal education, is too rarely accompanied by the use of efficient design representations. Architects use sketches – many iterations of them – because it helps to be able to visualise aspects of a solution and it is much more efficient to alter a sketch than a building (Schön, 1983, 157-60; Buxton, 2007). One role for computer-based educational design tools is to insert an editable representational layer between the ideas in the designer's mind and the world inhabited by the learner (see e.g. McAndrew et al., 2006; Botturi & Stubbs, 2008; Derntl & Motschnig-Pitrik, this volume). But much of what teachers currently do, we suspect, involves making strong, premature commitments in the world, rather than using intermediate design representations. Scope for visualising the learners' future experience, reflecting upon it, and editing designs, is thereby reduced. To the extent that our suspicion is correct, opportunities for improving educational design – and thereby improving learning – are being lost. Design without periods for informed reflection is hard to improve.

SHARING AND RE-USE

Educators have long been in the habit of reusing learning resources: textbooks, maps in Geography classes, periodic tables of the elements in Chemistry classes, films and videos, etc. As well as these resources, which are used directly with learners, educators sometimes also exchange lesson plans and other, more or less abstract, representations of how to teach.

The ability to share and re-use learning resources, lesson plans and the like has been greatly aided by the Internet. A general label that is now applied to a learning resource that is available via the Internet is a *learning object* (LO). According to IEEE LOM (2001), the term 'learning object' refers to any digital asset of learning material which can be used to support teaching or learning. In order to help people find learning objects that are relevant to their needs, descriptors for learning objects ('metadata') have been created and standardised. Standardised metadata makes it easier to discover, re-use and combine learning objects.

Currently there are a number of online learning object repositories (LORs). They serve several purposes, such as browsing and searching in a catalogue of LOs, booking/purchasing LOs, annotating/commenting on LOs, and contributing LOs. Among the best-known LORs are MERLOT (http://www.merlot.org), CAREO (http://careo.netera.ca) and COLIS (http://www.edna.edu.au/). Unfortunately, some of the work around LORs and reuse has led to a simplistic view that courses can be created by combining LOs, just like connecting Lego bricks (Koper, 2005). In fact, when teachers design or plan a lesson or a course they do not merely decide on the content and learning object resources but also need to specify the sequence of the tasks that the learner should tackle, within the constraints of the technology enhanced learning environment.

This is why an interesting shift in learning design occurred: to view sequences of learning activities as reusable objects – as templates that teachers could access and adopt/adapt to create a course. Learning design modelling languages such as IMS Learning Design (IMS LD 2003), E2ML (Botturi, 2006) and LAMS (Dalziel, 2003) have been proposed to formally describe the learning design. This is regarded as a time-ordered series of activities to be performed by *learning actors* (learners and teachers) within the context of a technology enhanced learning environment that consists of reusable LOs and services. With the wide adoption of such learning design specifications, a number of tools have been developed to help teachers/designers to create sequences of learning activities associated with tools and resources (Conole & Fill, 2005; Paquette et al., 2005).

However, these learning design specifications cannot illustrate clearly the pedagogical rationale of the design. Learning design patterns can be a solution to this problem since they can document designers' tacit knowledge and experiences and offer examples in a form that practitioners can apply in their own teaching context. How to combine formal (and computable) learning design specifications with learning design patterns is still very much a matter for debate.

DESIGN PATTERNS AND PATTERN LANGUAGES

The source of all the work on design patterns and pattern languages is the mathematical and architectural writing of Christopher Alexander, most notably in the trilogy of books he and his team produced in the late 70s (Alexander, 1979; Alexander et al., 1975, 1977).

There is an often-quoted definition of a pattern, with which we will start, though it needs some explanation. *A pattern is a solution to a recurrent problem, in a context.* In Alexander's own words, a pattern …

> "describes a problem which occurs over and over again in our environment, and then describes the core of the solution to that problem, in such a way that you can use this solution a million times over, without ever doing it the same way twice" (Alexander *et al*., 1977, p.x).

What is a solution?

A potentially confusing aspect of this definition arises from the way that problem and solution – especially solution – have come to mean different things in different areas of professional practice. In many fields of design practice, a solution is an artefact – it is a new thing, such as a door hinge or the atrium of a building. It may be quite simple (like a bottle opener), or very complex (like an airplane). In product design, any new thing that satisfies the design requirements can be described as a solution. In other fields of practice, a solution is a method rather than a thing. It says what has to be done.

The confusion is actually exacerbated by some ambiguities in Alexander's explanation of patterns (op. cit. pp. x-xi). He describes a solution as "the heart of the pattern – which describes the field of physical and social relationships which are required to solve the stated problem, in the stated context" (p.xi). We take this to refer to a thing (simple or complex) or a state of affairs. However, Alexander also says that a solution must be stated as an instruction – "so that you know exactly what to *do* to build the pattern" (p.xi, our emphasis). The mixing of method and artefact can be seen in many Alexandrian patterns. Here for example is the problem and solution text from Pattern #179 'Alcoves':

> "No homogeneous room, of homogeneous height, can serve a group of people well. To give a group a chance to be together, as a group, a room must also give them the chance to be alone, in ones and twos in the same space…
>
> Therefore:
>
> Make small places at the edge of any common room, usually no more than 6 feet wide and 3 to 6 feet deep and possibly much smaller. These alcoves should be large enough for two people to sit, chat, or play and sometimes large enough to contain a desk or a table." (op. cit., pp829-832).

The combination of method and artefact is embedded in that little word 'make'. This may seem trivial; indeed it may escape notice. But the lack of clarity about whether a pattern is a recurrent form or a set of steps – an omelette or a procedure for making an omelette – turns out to confuse people hugely in areas like education. A further source of potential confusion is that Alexander uses the term 'pattern' to refer to sets of arrangements in the real world, as with the alcoves, *and* to his particular way of describing these recurrent forms. (He uses the word 'pattern' to refer to both the territory and the map, if you will.)

The format of an Alexandrian pattern

Alexander's way of presenting a pattern is quite distinctive, though it is not used universally by those who have picked up his core ideas. In his own words again:

> "…each pattern has the same format. First there is a picture, which shows an archetypal example of that pattern. Second…each pattern has an introductory paragraph, which sets the context for the pattern, by explaining how it helps to complete certain larger patterns. Then there are three diamonds to mark the beginning of the problem. After the diamonds, there is a headline, in bold type. This headline gives the essence of the problem in one or two sentences. After the headline comes the body of the problem. This is the longest section. It describes the empirical background of the pattern, the evidence for its validity, the range of different ways the pattern can be manifested in a building, and so on. Then, again in bold type, like the headline, is the solution – the heart of the pattern….another three diamonds…show that the body of the pattern is finished. And finally…there is a paragraph which ties the pattern to all those smaller patterns in the language, which are needed to complete this pattern, to embellish it, to fill it out." (op. cit., pxi).

Here is an example of a pattern, described using the Alexandrian format, but taken from the world of education, rather than from architecture. We do not have space to give a full treatment of 'the body of the problem', which can be of several pages. Neither will we use pictures or diagrams. But the example should help the reader get more of a sense of how educational design patterns and pattern languages might work. The pattern we have chosen is the WRAPPER pattern, which describes a role that can be very useful when students are engaged in discussion tasks (Goodyear, 2009).

WRAPPER

> This pattern defines a role that is useful in a number of Group Task Patterns: notably DISCUSSION GROUP.
>
> ♦♦♦
>
> **In an active, spirited discussion, it's not easy for everyone to keep track of ideas and conclusions. Most people are concentrating on what they want to say next, rather than reflecting on, and trying to commit to memory, things that have been said. Good ideas get lost, and in the long run this can be demoralising.**
>
> *Body text explaining the basis of the pattern normally goes here.*
>
> Therefore:

Give one or two students the role of discussion WRAPPER. They should take notes during the discussion, capturing points of importance. These may be ideas or key arguments that shaped the discussion. They may be conclusions or decisions about the direction of future work. Brief the WRAPPER so that they focus on key ideas and don't try to record the whole history of the discussion. The WRAPPER should have five minutes or so at the end of the discussion to present their 'wrap'. Brief the other participants so that they know it's OK to ask the WRAPPER to note something down.

♦♦♦

Patterns needed to complete this pattern include: NOTEPAD, WRAP. SCRIBE is an associated role.

The wrapper pattern is self-explanatory. As an example of the Alexandrian form, we should just point out that DISCUSSION GROUP is a pattern that provides a context for the WRAPPER pattern. The WRAPPER pattern, in turn, can be a context for the NOTEPAD and WRAP patterns. (Looked at the other way up, the NOTEPAD and WRAP patterns are embellishments of the WRAPPER pattern, which in turn is an embellishment of the DISCUSSION GROUP pattern.) The text in bold, beginning 'In an active, spirited discussion…', is the problem statement, and the text in bold, beginning 'Give one or two students the role…', is the solution statement.

The WRAPPER pattern makes some sense on its own, but gains explanatory and practical power when presented as part of a pattern language. A pattern language can be seen as a set of patterns which are connected by being either contexts or embellishments for each other (see *Fig 1.2*). A pattern language is a way of gathering together a set of patterns such that a project of worthwhile scale can be tackled. Alexander's examples include building a house, or an extension to a house, or a porch. But he also uses the term 'pattern language' to refer to the whole collection of 253 patterns in his 1977 book. This ambiguity does not seem to us to be quite so problematic. In education, there must be a strong sense that the set of patterns is indefinitely extensible, or virtually so. That said, it is helpful to focus on pattern languages (in the more restricted sense) that help with recognisable kinds of educational projects – such as creating a new course, or moving a course from face-to-face to blended mode.

Figure 2. Seeing the WRAPPER pattern as part of a pattern language.

There have been quite a number of attempts to use a patterns-based approach in areas of human endeavour outside architecture. Some of the best work in education, particularly in relation to technology-enhanced learning, has been carried out by the colleagues who have written the chapters of this book. There was also some early work on pedagogical patterns, led by people who taught software engineering and who had been involved in developing patterns for object-oriented software design (Sharp et al., 2003). More recently, patterns and pattern languages have been developed in various branches of work on human-computer interaction (e.g. Graham, 2003, Tidwell, 2006; Dearden & Finlay, 2006), organisational change (e.g. Coplien & Harrison, 2004) and distributed social activism (e.g. Schuler, 2008).

QUESTIONS OF VALUE

Some of the intellectual roots of work on educational design patterns lie in the older field of instructional design. One reading of instructional design positions it as a rational, technical enterprise, concerned with optimising learning and instruction through the application of objective scientific principles. This reading of instructional design does not foreground questions of *value*, other than the privileging of instructional efficiency and effectiveness. This muted treatment of values can also be found in areas of TEL design, including some of the work aimed at providing tools that help teachers as designers. As we mentioned earlier, one sometimes comes across claims that a method or tool is ‘pedagogically neutral’, as if that were unquestionably a good thing.

We mention this because Alexander’s writings are suffused with value commitments. Patterns and pattern languages are not just neat formats for communicating solutions to problems: patterns have a moral component (they are meant to make life better); they are intended to enhance coherence in the things that are made from them; they are meant to be generative – empowering people to strengthen coherence in the things and places they create (Alexander, 1999, p. 74). Much of Alexander’s work has been a search for the qualities that draw us to good buildings and to other places that make us feel more alive and whole. He is highly critical of many features of modern industrial life, seeing the outcomes of 'mechanical' design as squashing and eroding those things that make us human.

We think it would be inappropriate – to put it mildly – to adopt Alexander's patterns as mere communicative tools, without acknowledging the way they intertwine with deep considerations of value. In earlier work (Goodyear et al., 2004), we drew attention to some of the jagged edges of modern 'industrial' education and talked about how the use of TEL, if well thought through, could lessen the damage. We might now go further and say that *good* TEL design is characterised by a commitment to helping people create circumstances in which learning can be experienced as coherent with what is most deeply valued in the rest of life, as a source of pleasure, growth and transformation. On this view, *bad* TEL design leads to fragmented, alienating and/or dispiriting experiences.

OVERVIEW OF THE CHAPTERS

It is possible to dip into the chapters in any order, though each of the chapters assumes the reader has been introduced to the foundational ideas and terminology presented above. That said, there *is* a logic to our sequencing. We get underway with a more extensive examination of architectural sources of inspiration (Chapter 2), but then offer a rich sequence of examples of work that colleagues have been doing with patterns in the complex field of computer-supported collaborative learning (CSCL). Design patterns and (more or less explicit treatment of) CSCL provide a connecting theme for chapters 3 to 7, though as we shall explain shortly, each of the chapters also illuminates a unique set of educational, design and technical issues. Chapters 7, 8 and 9 sketch some of the bridges that link patterns-based work in software engineering with patterns-based work in the area of TEL. Software development for TEL is notoriously difficult and these chapters simultaneously explain some of why this is so, and point to ways in which patterns-based development may turn out to be particularly productive. Chapter 10 begins a sequence of chapters that focus more strongly on the educational aspects and applications of TEL design patterns: looking at evaluation, the treatment of pedagogical rationales, and the language used in networked learning. Chapters 13 to 17 are linked by interests in organisational issues: from the use of patterns in organisational learning to methods and tools for sharing the work of pattern creation.

Let us now turn to a quick overview of each of the chapters.

Andrew Gibbons' chapter (Chapter 2) can be seen as an extension of the architectural work on instructional design layers that he has written about with Clint Rogers (Gibbons & Rogers, 2009). The conceptual separation of designs into discrete layers is a useful way of handling complexity without resorting to reductionism. Gibbons discusses a number of key issues, desiderata and important functions in relation to each of seven design layers, and then identifies patterns to address each of these design considerations. There is not enough space to go into details of the 77 patterns listed. In our view, a significant part of Gibbons' contribution is that it helps organise perspectives on educational design, not least through identifying some of its main dimensions.

In Chapter 3, Davinia Hernández-Leo, Juan Asensio-Pérez, Yannis Dimitriadis and Eloy Villasclaras-Fernández describe the derivation, architecture and application of a set of design patterns tuned to the needs of computer-supported collaborative learning (CSCL). Research in CSCL has shown how it *can* have considerable educational benefit, but that slips in implementation can reduce these benefits considerably. One way of strengthening the implementation, and associated benefits, of CSCL is through the use of scripts, which help structure students' activity and ensure they have access to the tools and resources they need. Hernández-Leo et al. show how patterns and pattern languages for CSCL can be used to generate CSCL scripts for specific courses or programs of educational activity. A particular strength of the chapter comes from its attention to the ways in which patterns can be combined: they offer a number of principles underpinning logical strategies for combining patterns.

In Chapter 4, Stephan Lukosch and Till Schümmer provide an overview of their work developing patterns and pattern languages in the area of computer-mediated interaction, focussing on the particular domain of CSCL. Their chapter is specially useful in alerting us to the need for integrating many different kinds of patterns in the development of CSCL/CMI environments. Some of the necessary patterns are quite generic and apply across a broad range of social or technical design areas. Others are much more specific to learning interactions. The important thing is that designers and developers, and sometimes end users, need to manage complex combinations of these different kinds and levels of patterns. Conceptual clarity is a necessity, not a luxury, in this regard.

Franca Garzotto and Caterina Poggi (Chapter 5) explore a specific and still little-known areas of CSCL – namely, collaborative learning in 3D virtual worlds (such as Second Life). They rightly identify the design of 3D CSCL environments as complex, and show how design patterns can be used to capture and share relevant design knowledge. The authors draw on a wealth of experience of creating and evaluating 3D CSCL environments. They show how patterns can be used as a common way of representing experience about quite diverse (but complementary) design areas. Garzotto and Poggi's example patterns are concerned with (i) learner experiences and (ii) the affordances of the 3D virtual world being designed as a space for experience. This nicely illustrates the way that different kinds of research-based design knowledge can feed into different layers or components of the design problem, while all the time using the common patterns-based representational format.

Christian Voigt (Chapter 6) is also interested in the use of design patterns to help support CSCL, but his chapter moves the discussion up a level by focussing on how we might best understand *context* in relation to patterns. Drawing on Star's 'boundary objects' and Engeström's 'activity systems', Voigt argues that understanding the functioning of *patterns in use* is key to working out the implications of context. Voigt's chapter is especially useful for thinking about some of the dynamics of CSCL, e.g. as student groups form, develop norms, run into difficulties, etc.

Patterns can sometimes take on a static feel and Voigt's chapter is good at breathing life into them.

Rafael Calvo and Aiman Turani (Chapter 7) use their synchronous CSCL system Beehive as a vehicle for showing how educational design patterns can be linked to software components to create TEL frameworks. Following terminological usage in software engineering, a TEL framework can be thought of as an integrated combination of design patterns and software components, where the design patterns encapsulate design experience, guidance, etc and the corresponding software components mean that chosen designs are runnable. Their Beehive example draws on some of the seminal work of Morten Paulsen, who identified a number of successful CSCL techniques, together with their requisite resources. Calvo & Turani's work builds on Paulsen in a convincing demonstration of how to move from experience to design patterns to runnable CSCL software.

César Moura, John Hicks and Alain Derycke (Chapter 8), like Calvo and Turani, are interested in connecting patterns to software, but their argument is somewhat different. Moura et al describe work associated with the development of the MDEduc system, focussing particularly on the role of *informal representations* in the design and development of TEL software. They see pedagogical patterns as interesting examples of such informal representations. They make the compelling point that maintenance of informal representations, after the implementation of TEL software, is potentially very valuable. This flies in the face of some software development thinking, where informal representations are seen as merely a means to the end of creating software, and are therefore disposable. Moura et al rightly argue that informal representations do not just help with getting the design right, but also with getting the right design. By going back to the informal representation – in this case a pedagogical pattern or pattern language – designers and developers can check whether the original design ideas were actually as good as people first thought, whether they could be improved upon, whether they *quite* capture best practice.

Chapter 9 (Andreas Harrers and Alke Martens) shows how patterns and pattern languages can help bridge between the worlds of pedagogy and systems design. Harrer & Martens take us into some high-level design and implementation issues that are relevant to complex TEL systems, including intelligent tutoring and collaborative learning systems. This work forges another set of connections between the mainstream software engineering tradition of patterns-based development, and work on pedagogical patterns. The chapter hints at some interesting emerging tensions – over desiderata for design patterns – between specialists in different areas, as well as showing how communications between different specialisms might be improved.

In Chapter 10, Petros Georgiakakis, Simeon Retalis and Yannis Psaromiligkos shift our attention to issues of TEL evaluation. They make the point that expert TEL evaluators are scarce and expensive, and that there are strong arguments for upskilling, and scaffolding the work of, less experienced and non-specialist evaluators. The authors' DEPTH evaluation methodology uses design patterns as a way of making the TEL knowledge of experienced evaluators available to novices.

The chapter describes a case study in which a group of novice evaluators made successful use of the DEPTH approach. It can be argued that the future of TEL is one in which user/learners, teachers and others will be involved in loose collaborations through which TEL environments are co-configured and customised. In such circumstances, it makes a great deal of sense if *everyone* involved can play a role in the ongoing evaluation and improvement of TEL environments.

Fiona Chatteur, Lucila Carvalho and Andy Dong (Chapter 11) provide a worked example of an elaborated structure for a design pattern, with the intention of providing stronger and more explicit links between pedagogical theory and design advice. They work from published literature towards the design pattern, and nicely contrast this methodology with 'reverse engineering' or abstracting patterns from successful practice. A notable feature of their approach is the space and care given to incorporating what might be called 'deep pedagogy'. They are unconvinced by the treatment of pedagogical explanation and justification in much of the existing patterns-based work, and use an extended pattern format to ensure that the subtleties of pedagogical reasoning can be captured and shared.

Dai Fei Yang (Chapter 12) explores some similarities and synergies between the application of Systemic Functional Linguistics (SFL), to analyse language use, and the construction of design patterns to capture valued educational practice. In many TEL situations, interaction between teachers and students is mediated through online texts, so understanding the subtleties of language use can provide some penetrating insights for those wishing to capture teaching expertise in pattern form. Yang also draws some convincing analogies between Alexander's concerns about the alienating effects of industrial architecture and the alienating effects on students of industrial teaching methods.

In Chapter 13, Michael Derntl and Renate Motschnig-Pitrik reflect upon their experience of crafting and using design patterns in the context of teaching university-level informatics and computer science courses. This is a powerful chapter because it draws on deep, hard-won experience of working seriously with design patterns, and the authors' reflections are also informed by a broader understanding of issues in process modelling, visual languages and educational evaluation. The authors insist upon the importance of a firm and clearly-articulated value base, on which to construct educational designs, and argue strongly for a pragmatic view on design patterns – recognising strengths and limitations, and grounding design claims in firm evidence from student evaluations. The Vienna collection of design patterns, in our view, represents one of the most significant achievements to date in this field.

Winters, Mor and Platt (Chapter 14) have also been working on the creation of a pattern repository and offer a compelling illustration of the argument that tools and community practices are interdependent. They describe the d2n approach that they adopted to help a distributed, multidisciplinary community of teachers, researchers and technical specialists collaborate on the development of an extensive set of mathematics education patterns. The actual learning patterns work and its outcomes have been documented elsewhere (see e.g. Pratt et al., 2006). In this chapter, the authors focus on some of the tools they used to support collaborative design work: especially on ways of interrogating and working with the shared repository of evolving patterns. Chapter 14 is particularly instructive because of the seriousness with which it treats distributed design methodology – forging firm links between the tasks and social practices of design, on the one hand, and the functions and affordances of the design database tools, on the other.

Till Schümmer (Chapter 15) explores the idea of a pattern scout as an aid to organisational learning, in the sense of someone who helps members of a community of practice (or a company, or some other kind of formal organisation) to identify and document best practice. Drawing on Schön's notion of reflective practice, Schümmer identifies one of the key difficulties of sharing professional knowledge in rapidly changing areas – that much of what turns out to be the most valuable knowledge is tacit, hard and time-consuming to articulate, and contestable. Schümmer uses the idea of *protopatterns* as ways of capturing and sharing emerging practices, prior to the point at which repeated successes or empirical evidence give the practices the solidity or status of established patterns.

In Chapter 16, Gráinne Conole & Chris Jones shift our attention up a level: to institution-wide issues. They are particularly concerned with methods of sharing educational design ideas during times of institutional change. Their example is situated in the UK's Open University, and relates to the introduction of a new institution-wide virtual learning environment (VLE). The chapter explores the complementarity of pedagogical patterns and visual learning design, and offers a detailed description of a tool for visualising designs (CompendiumLD) that is being trialled in the OU. Conole & Jones locate their work at the meso-level of institutional activity: where top-down and bottom-up processes meet, and institution-wide structures interact with local actions. Among other valuable insights, this underscores the importance of seeing local design as constrained by the structures and processes that are created and maintained at higher levels in the institution. Design rarely works on a 'greenfield' site.

In Chapter 17, Maria Zenios and Christine Smith extend this exploration of institution-level issues, using the idea of an 'e-learning centre' or a 'TEL centre'. Zenios & Smith use this label to identify a unit, within a larger organisation such as a university, that has responsibility for serving the learning needs of students and staff, and especially for helping with educational innovation that involves TEL. Their survey-based analysis of the requirements that universities place on e-learning centres underscores the need to manage a complex set of competing priorities – a task for which organisational design patterns are well-suited. They identify ten areas that require attention from centre management – from vision to benchmarking – and sketch some design patterns that suggest ways of balancing some of the associated tensions.

Finally, Symeon Retalis, Agnieszka Bachfischer and Peter Goodyear review some of the achievements of the field and identify some opportunities for further research (Chapter 18).

CONCLUDING COMMENTS

Christopher Alexander's vision is one of enabling people to regain control of important aspects of their lives, including the ability to help imbue their environment with qualities that make the experience of place more pleasurable and coherent. His exploration of the qualities that make places 'alive' has spanned nearly half a century (Alexander, 1964; 2006). Our work exploring the qualities of good learnplaces – physical, digital, hybrid – has really only just begun. Early results look promising, as we hope this collection will demonstrate.

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