Patterns, pattern languages and educational design

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This paper introduces design patterns and pattern languages as conceptual tools to support educational design in the context of networked learning. The patterns-based approach has origins in the work of the architect and mathematician Christopher Alexander. More recently, others have developed ideas about the use of patterns in software engineering, pedagogy and online learning. This paper goes back to Alexander's work and rediscovers some neglected aspects of the approach, that can be particularly helpful in encoding, sharing and using knowledge for educational design.

Keywords: networked learning, educational design, design patterns, pattern language

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Introduction

A serious challenge for research in education and the learning sciences is the transformation of the outcomes of systematic enquiry into usable knowledge for educational practitioners. Candidate responses to this challenge tend to start at the production end: how to pose research questions to provide a better fit with practical problems; how to disseminate research in jargon-free, accessible language; how to contextualise research findings and put appropriate limits on generalisation, etc. In contrast, this paper starts at the point of consumption, outlining a model of the use of research-based knowledge in educational design. The model characterises design as an iterative 'conversation with materials' (Schon, 1983). The paper argues a case for methods of representing design knowledge that reflect the need for alternating periods of fluidity and commitment – provisional stability – in educational design. It exemplifies the approach by reference to recent work on educational design for networked learning in higher education.

Networked learning

The terms e-learning, web-based learning and online learning now have wide currency in education. I use the term networked learning to mean a distinctive version of these approaches. I define networked learning as:

> learning in which information and communications technology (ICT) is used to promote *connections*: between one learner and other learners; between learners and tutors; between a learning community and its learning resources (Goodyear, Banks, Hodgson, & McConnell, 2004, p1)

Some of the richest examples of networked learning involve interaction with online materials and with other people. But, in my view, use of online *materials* is not a *sufficient* characteristic to define networked learning. Human-human interaction, through computer-mediated communication or CMC, is an essential part of networked learning.

The pedagogies of networked learning, naturally enough, emphasise the potential benefits of learning through collaboration with others – whether through online discussion, argumentation, group-based investigations, apprenticeship, community action or other forms of joint work (Goodyear, 2002a; Jonassen & Kwon, 2001; Koschmann, 1996; McConnell, 2000). There is often a gap between teachers' hopes and educational outcomes, such that it is becoming common to read evaluation reports and research studies which describe teacher disappointment and/or student frustration (Hara & Kling, 1999; Jones & Asensio, 2002; Jones, Asensio, & Goodyear, 2000; Romiszowski & Mason, 2004). The variability in outcomes is, at least in part, due to variation in the quality of teachers' design activity. Successful networked learning depends, to a considerable extent, on well-targeted effort at design time – designing good learning tasks, ensuring good access to robust and appropriate technology, and helping create a convivial learning environment. Recognition of the importance of educational design has led to the production of books and other resources which are intended to support the teacher's design activity (Goodyear, 2001; Oliver et al, 2002; Salmon, 2000, 2002; Stephenson, 2001). Although such resources have generated positive feedback, we know little about how they are actually used in practice and even less about how well they act as conduits for either research-based or experiential design knowledge.

Design methodologies

The field of educational technology has built up considerable experience of using structured design methodologies, especially in the production of interactive, individualised, computer-based learning materials or courseware (de Jong & Sarti, 1994; Goodyear, 1997; Jonassen, 1988; Naidu, 1993; Pirolli, 1991; Reigeluth, 1999; Spector, Polson, & Muraida, 1993; van Merrienboer, 1997). However, there are few examples of successful attempts to deploy such methodologies in the area of networked learning. Rather, the tendency has been for leading writers in this field to position the problem of educational design at the levels of either broad pedagogy and philosophy (e.g. McConnell, 2000) or specific pedagogical techniques (e.g. Salmon, 2000; 2002). The middle ground is the difficult territory in which philosophy and pedagogical tactics have to be aligned. It is a space in which the problems of design can be complex, and can be especially demanding for those who are new to networked learning (Figure 1).

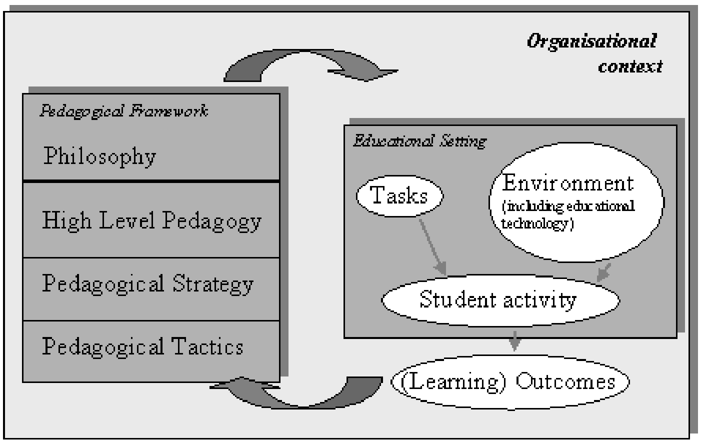

Figure 1: Pedagogical frameworks: internal structure and relations to tasks and activity (Goodyear, 1999)

Figure 1 depicts a pedagogical framework as a loosely coupled structure in which relations can be made between pedagogical philosophy (how we think people learn, what knowledge consists of, how we think people should be treated, etc.), high level pedagogy (broad approaches such as problem-based learning, cognitive apprenticeship, collaborative knowledge-building), pedagogical strategy (e.g. the use of an online debate) and pedagogical tactics (the detailed methods we use to set tasks for students, encourage their participation, offer guidance and feedback, etc). The loose coupling is important. As we have moved away from formal and highly structured methods of instructional systems design, so it has become less tenable to argue for strict deductive relationships between these levels. One can no longer pretend to be able to infer tactics from strategy, for example (c.f. Tennyson, 1994). But *some* degree of coupling is important, in order that we can manage a satisfactory degree of alignment between philosophy, general pedagogical approach, strategy and tactics (Biggs, 1999).

On the right hand side of Figure 1, we see a concrete educational setting – a situation in which the predispositions and methods in our pedagogical framework become realised. The design focus is on the tasks we set students and on the resources – human, physical, digital – that constitute their learning environment.

The value of Figure 1 is that it helps separate and relate the abstract and the concrete, the general and the specific, beliefs and actions. It is one way of depicting the problem space of educational design.

Educational design in practice

To get a better understanding of how educational design can best be supported and improved, we need to have some clear ideas about educational design in practice. There are many more *normative* models for educational design than there are accounts of actual design activity (Hoogveld, Paas, Jochems, & van Merrienboer, 2002). Similarly, there are more normative models for online teaching than there are empirical studies of online teaching in action (Goodyear, 2002b).

What we *can* reasonably infer from the research is that educational design for networked learning – as carried out by the individual teacher in higher education - is typically a process extending over a period from a few hours to a small number of days, and involves several iterations around a cycle of articulating design goals (what am I trying to achieve here?) and educational design commitments (What will I ask the students to do? How will I group them? What reading material will they need? etc). Within this process, it is common for the designer to make provisional commitments (How do I know what I think until I see what I've designed?) and to backtrack. It's a fluid process, involving a conversation between the pedagogical beliefs, knowledge and intentions in the mind of the teacher-designer and (provisional) design commitments. The design commitments are mostly made in the online space: draft instructions for the students, allocation of students to discussion groups or project teams, placing reading lists and links to e-journals in convenient locations, etc. For increasing numbers of teachers in higher education, this iterative design work takes place using a learning management system or virtual learning environment, such as WebCT or Blackboard. Depending on local arrangements and practices, this may mean their design work is further supported by templates, examples of designs used by others, resources and methods used in previous years, etc. They may also have access to external example designs, such as those provided on the 'Learning Designs' website at the University of Wollongong (http://www.learningdesigns.uow.edu.au/index.html) – Oliver et al (2002).

What they are *unlikely* to have is a set of example designs, or guidelines for design, structured to match the kind of arrangement depicted in Figure 1. That is, the resources available to the teacher engaged in educational design are hard to relate to one another, and hard to locate in relation to a particular pedagogical framework. Moreover, it is unusual to find examples and templates constructed in such a way that they capture, and distil the practical implications of, research-based knowledge.

Design patterns and pattern languages

The remainder of this paper introduces the idea of design patterns and pattern languages for networked learning. The claim is, that this patterns-based approach has a good deal to offer educational design, particularly in relation to:

- Providing the teacher-designer with a comprehensive set of design ideas
- Providing these design ideas in a structured way – so that relations between design components (design patterns) are easy to understand
- Combining a clear articulation of a design problem and a design solution, and offering a rationale which bridges between research-based evidence and experiential knowledge of design
- Encoding this knowledge in such a way that it supports an iterative, fluid, process of design, extending over hours or days.

The original ideas for design patterns and pattern languages come from the writings of Christopher Alexander on architecture and town-planning - see, for example, Alexander (1979; Alexander et al. (1977). Alexander's intention was to democratise architecture and town-planning by offering a set of conceptual resources that ordinary people could use in (re)shaping their environment. His work provides a principled, structured but flexible resource for vernacular design. In my view, he strikes the right balance between rigour and prescriptiveness - offering useful guidance without constraining creativity and providing helpful foci for design.

The notion of design patterns has been picked up more recently within the field of software engineering - where it has been used to capture and share aspects of software engineering experience and as a way of representing successful models for the implementation of information systems (see e.g. Gamma, Helm, Johnson, & Vlissides (1995). Teachers of software engineering have also been experimenting with the idea of pedagogical patterns and educational technologists have been trying to apply a patterns-based approach to working on problems such as learning object descriptions, inter-operability, learning management standards, etc. (Avgeriou, Papasalouros, Retalis, & Skordalakis, 2003; Eckstein, Marquardt, Manns, & Wallingford, 2001; Frizell & Hubscher, 2002a, 2002b; Goodyear et al., 2004; Lyardet, Rossi, & Schwabe, 1998).

Design patterns have a number of qualities which, in combination, give them the potential to be a useful way of sharing experience in the field of networked learning. 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). Context is important in helping constrain and communicate the nature of both problem and solution. Describing the context for the problem and its solution avoids over-generalisation. In addition, patterns should also teach. They should be written in such a way that they help the reader understand enough about a problem and solution that they can adapt the problem description and solution to meet their own needs. The rationale for the pattern helps with this teaching or explanatory function. Ideally, the name of the pattern should crystallise a valued element of design experience and help relate it to other design elements such that we can create and use a pattern language. The use of patterns, then, can be seen as a way of bridging between theory, empirical evidence and experience (on the one hand) and the practical problems of design.

Alexandrian patterns have the structure shown in Figure 2. (See for example, Alexander et al, 1977, x-xi.)

A picture (showing an archetypal example of the pattern) [easier in architecture than networked learning]
An introductory paragraph setting the context for the pattern (explaining how it helps to complete some larger patterns)
◆◆◆
(to mark the beginning of the problem)
A headline, in bold type, to give the essence of the problem in one or two sentences
The body of the problem (its empirical background, evidence for its validity, examples of different ways the pattern can be manifested)
The solution, in bold type. This is the heart of the pattern – the field of physical and social relationships which are required to solve the stated problem in the stated context. Always stated as an instruction, so that you know what to do to build the pattern.
A diagrammatic representation of the solution
◆◆◆
(to show the main body of the pattern is finished)
A paragraph tying the pattern to the smaller patterns which are needed to complete and embellish it.

Figure 2: the structure of a typical Alexandrian pattern.

An example pattern relating to networked learning is given in Figure 3. The example is taken from a set of patterns developed to represent the pedagogical techniques summarised and popularised by Morten Paulsen (Paulsen, 1995). These techniques cover ‘one-alone’, ‘one-to-one’, ‘one-to-many’ and ‘many-to-many’ scenarios. The ‘many-to-many’ techniques are: Discussion groups; Debates; Simulations or games; Role plays; Case studies; Transcript based assignments; Brainstorming; Delphi techniques; Nominal group techniques; Forums; Project groups; Joint programme and Joint cohort discussions and Visitor experts.

Discussion group

This pattern is mainly concerned with the establishment of appropriate organisational forms for knowledge-sharing, questioning and critique. It is a way of helping implement the patterns LEARNING THROUGH DISCUSSION, COLLABORATIVE LEARNING and NETWORKED LEARNING PROGRAMME.

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Discussion groups are the most common way of organising activity in networked learning environments. The degree to which a discussion is structured, and the choice of structure, are key in determining how successfully the discussion will promote learning for the participants.
Discussions can be relatively structured or relatively unstructured, and they may also change their character over a period of time. It is not uncommon for a teacher to set up a discussion in quite a formal or structured way, and for the structure then to soften as time goes by – for example, as the participants take hold of the conversation, opening up and following new lines of interest.
The structure of a discussion should be such that it increases the likelihood of:
a) an active and substantial discussion, with plenty of on-task contributions
b) the students coming away from the discussion with a good understanding of the contributions made
c) contributions being made by all members of the group and 'listened' to by all other members of the group.
Unstructured discussions run the risks of (for example)

- not getting going properly within the time available
- dissipating into a number of loosely related strands that fail to engage effectively with subject being studied
- dissolving into monologues or two-way conversations that fail to involve the whole group (Wertsch, 2002).

Pilkington & Walker (2003) have demonstrated the value of assigning explicit group roles in online discussion groups. Some writers, for example, McConnell (2000) are not sure about the validity of the teacher setting specific structuring devices, preferring to make the group itself responsible for determining how it wants to discuss things, or carry out its work more generally.
Therefore:

Start any online discussion by establishing its structure. Make the rules and timetable for this structure explicit to all the members of the group. Where there is little time available to the group for the discussion, and/or the members of the group are inexperienced at holding online discussions, the teacher/facilitator should set the structure. Where the students are to set their own structure, the teacher/facilitator should give them support and ideas about how to do this, and encourage them to do so in a fair and timely way.

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Patterns needed to complete this pattern include: DISCUSSION ROLE, FACILITATOR, DISCURSIVE TASK

Figure 3: Design pattern for discussion group

What the example in Figure 3 should begin to do is convey a sense of how design patterns can work as a method of encapsulating design experience and research-based ideas, rendering them available for re-use in concrete design problems.

But design patterns on their own are rather hard to evaluate and to use. They gain a great deal of meaning and strength from their position in a structure, and especially a sequence, of other patterns. Alexander's seminal contribution consisted of 253 patterns, ranging in scale from an INDEPENDENT (geographical) REGION to an ORNAMENT. He called the whole assemblage a pattern language, but also used smaller pattern languages for specific projects (such as building a porch – for which he provides a pattern language consisting of just ten patterns).

Thinking in similar ways about the design space of networked learning, one can advance some tentative proposals about an equivalent pattern language. What would be the largest pattern, equivalent to

Alexander's 'Independent region'? I suspect it would be a course, or Programme of study. This is the largest entity which can be designed. At smaller scale levels there are the building blocks of a course, however one labels them in one's own system or institution – Study unit, Module, etc. Then there are the kinds of pedagogical technique catalogued by Paulsen: Discussion group, Debate, etc. Within these are smaller pedagogical tactics (tasks), smaller organisational forms, as well as the tools and artefacts with which we populate the learning space.

Forming a pattern language for networked learning involves painstaking, iterative work, travelling in two directions. From the bottom up, one can sketch individual design patterns, to capture recurrent problems and solutions from our collective experience as networked learning practitioners, interpreting these also through the lens of research-based evidence and theory. From the top down, one can try to structure the problem space of design, scoping out the largest and smallest patterns, and sketching relationships between patterns (written and as yet unwritten). Neither approach is sufficient on its own and each can lead to contradictions and problems for the other – hence the need for iteration, revision, patience and a tolerance of ambiguity.

Table 1: Patterns for networked learning

Tasks	Organisational Forms	Space (tools, resources)
Discuss	Dyad	E-print
Debate	Triad	E-journal
Brainstorm	T-group	Virtual library
Investigate	Learning set	Discussion board
Critique	Tutorial group	Chat room
Assess	Seminar group	Whiteboard
Summarise	Whole class	Shared folder
Solve puzzle	cohort	Wiki
Write essay	Project team	Virtual café
Develop tool		Portal
Memorise	Roles:	
	Summariser	Textbook
	Motivator	Study bedroom
	Self-selecting group	

Table 1 gives a list of some candidate patterns for networked learning. There is no suggestion that this is a complete list. The patterns are structured according to whether they are mainly concerned with tasks to be set for the students (column one), ways of organising students into groups and/or specific roles (column two), or the tools and resources that need to be made available in the networked learning space or in the student's learnplace (column three).

Figure 4 shows how patterns can be combined into a pattern language for a specific kind of networked learning activity – in this case, borrowing again from Paulsen's pedagogical technique of 'debate'.

Figure 4, like table 1, is structured according to tasks, organisational forms and tools/resources. The sequence of tasks needed to constitute a debate is given in the left hand column. Roles are listed in the centre, with links showing connections between roles and tasks. In the right hand column are some options for appropriate online technology and resources. Each of the elements in the figure is a pattern. Each is simply described using the formalism shown in Figures 2 and 3. Each makes sense individually but also when combined in the structure – the pattern language – shown in Figure 4.

Concluding comment

Designing for networked learning in higher education is not easy. We know very little about how teachers in higher education actually engage in design work and we are probably too ready to generalise from our own activity. However, what we do know about the practices and demands of educational design suggests

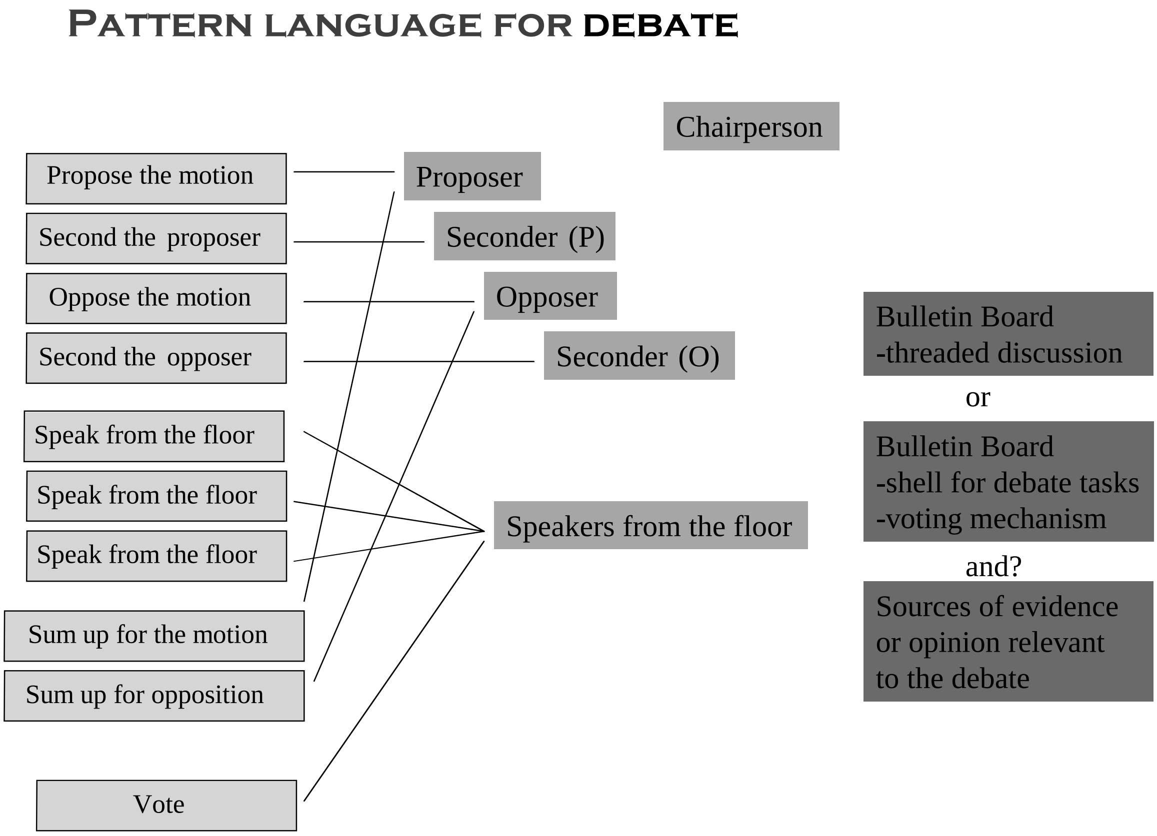

Figure 4: Pattern language for 'debate'

that our ways of representing and sharing design experience – mainly through texts – need improvement. This paper has sketched an approach, using design patterns, which has potential to capture usable design knowledge, build bridges between practical problems and research-based evidence, and help designers see both the wood and the trees when they are engaged in design work. Much more needs to be done before we have a robust and shareable pattern language for networked learning, but this paper represents a milestone along the way.

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