Chapter 13
Technology-Supported Design for Inquiry-Based Learning

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Abstract This chapter explores the role of digital technology in supporting higher education teachers to design for inquiry-based learning (IBL). It begins by introducing the idea of 'design for learning' and by summarising key features of IBL pedagogy. A pedagogic planner tool is appended to highlight considerations for IBL design. The chapter then moves on to review the findings of a research project that investigated university teachers' approaches to design for learning and their use of a computer-based design tool, the learning activity management system (LAMS) to create IBL learning designs. Using a qualitative research approach, the project identified variation in teachers' conceptions of IBL pedagogy and in their approaches to design for learning. LAMS, in the version used, was found to offer design affordances that are especially consistent with teacher-led, rather than student-led, approaches to IBL pedagogy. The issues arising from this research are of relevance to academic developers in higher education and to the further development and use of digital design tools for IBL.

13.1 Introduction

This chapter explores the role of digital technology in supporting teachers to design for inquiry-based learning (IBL) in higher education. The chapter begins by introducing the idea of 'design for learning' and by summarising key features of IBL pedagogy. Appendix presents a pedagogic planner tool that draws attention to considerations for IBL design. The chapter then moves on to review the findings of a research project, reported in more detail by Levy et al. (2009), which investigated university teachers' approaches to designing for learning and their use of a computer-based tool, the learning activity management system (LAMS), to create

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13.2 Design for Learning

Design for learning is not a new concept and has historical roots in the field of instructional design (Britain 2004; MacLean and Scott 2011). The principle goal of design for learning is to engage students in meaningful and productive learning activity, mediated by tasks established by the teacher-designer. According to Beetham (2007), a learning activity is an interaction of learner(s) with other(s) and with an environment, digital or not, that provides access to resources, tools and services. It is carried out in response to a task that is aligned with specific learning outcomes. Tasks designed by teachers provide the stimulus for student activity, although in any particular context, inevitably, this is influenced also by contingencies that teachers cannot control (Ellis and Goodyear 2010). Design for learning can be seen as a form of situated action, influenced by the beliefs and values held by teacher-designers; it is an emergent, iterative process that occurs during, as well as prior to, the actual learning activity (Jones and Asensio 2002). When students are involved as co-designers of their own learning in higher education, the distinction between learner and teacher roles in design for learning begins to blur.

Since the late 1990s, the idea of design for learning has been adopted and developed by the e-learning research and development community. One key area of interest is in the role that digital technology might play in the creation of shareable representations of learning tasks, resources and teaching interventions, as vehicles for the development and dissemination of good pedagogic practice. In this context, definitions of design for learning (or, alternatively, 'learning design') vary. The UK Joint Information Systems Committee has described design for learning as 'the process of designing, planning and orchestrating learning activities' (JISC 2006). Beetham and Sharpe (2007: 6) offer a definition that excludes the element of orchestration: 'the process by which teachers—and others involved in the support of learning—arrive at a plan or a structure or design for a learning situation'. Another definition explicitly includes the aspect of description, seeing design for learning as, 'the planning and documentation of a learning activity, session or curriculum in advance of delivery' and 'a learning design' as the documented outcome of the design process (Falconer and Littlejohn 2007: 42). In this chapter, design for learning (and, interchangeably, learning design) is understood as the planning and representation of learning activity for any scale of learning event. It is worth noting the important distinction between design for learning as a general concept, and the IMS Learning Design specification that offers a standard language for the description of learning designs (Koper and Olivier 2004).

As discussed by Masterman and Vogel (2007), it is common for teachers in higher education to use general purpose software such as word-processing, mind-mapping and presentation tools to author designs for learning. Virtual learning environments (VLEs) also may be used as design environments (Vogel and Oliver 2006). However, in recent years, software specifically intended to support the creation, sharing and re-purposing of designs for learning has been developed. Britain (2004, 2007) provides an overview in which he differentiates between authoring software and integrated software. Authoring software provides design tools for learning activities that might take place online or offline, but that is not intended for use by learners during the learning activity. One example is the compendium LD system described by Conole et al. (2008). Integrated software (such as LAMS) offers combined authoring and 'run-time'—that is, learning activity orchestration, or implementation—functionality. Britain (2007) suggests that integrated design for learning software reduces complexity for designers but may also serve to constrain design possibilities if design and run-time functionality are closely coupled.

13.3 Designing Inquiry-Based Learning

Interest in strengthening the role of student inquiry in higher education is growing internationally. Studies have identified benefits relating to students' engagement with academic work, their subject learning, and their intellectual, professional and personal development (e.g. Brew 2006; Healey and Jenkins 2009; Justice et al. 2007; Lee 2012; Levy and Petrulis 2012).

Definitions and conceptions of IBL pedagogy differ. Perhaps IBL is best seen as a family of approaches in which student-led exploration, investigation or research drives the learning experience, and all learning tasks, assessments, teaching interventions, resources and environments are designed to support an emergent process of exploration and discovery. Students use the scholarly and research practices of their discipline to engage with authentic discipline-based or inter-disciplinary questions and problems. Productive IBL is generated by purposeful, creative engagement with well-designed inquiry tasks in a learning environment that provides an appropriate balance of challenge and support. Inquiry tasks may be less or more flexible, and small or large in scale. Students often work collaboratively and use digital technologies to interact with peers and tutors, access information, and produce and share outputs. They often are encouraged to share the results of their inquiries with peers and wider audiences.

Use of inquiry approaches in teaching typically reflects strong commitment to the educational values and beliefs of student-centredness and learner empowerment, with teachers aiming to encourage students to embrace a significant amount of responsibility for their learning. However, IBL can take a variety of forms to suit different educational purposes. For example, while some forms of IBL engage students with questions to which answers already exist, IBL often is conceived as a

means of engaging students with uncertainty and the contested nature of knowledge, and with authentically 'messy', open-ended problems. IBL that is oriented towards open questions and problems offers potential for productive interaction between research and teaching in higher education (Spronken-Smith and Walker 2010). At the same time, some modes of IBL are more teacher-led, in which the teacher sets the questions and offers a great deal of guidance on the inquiry process, while in other modes, students have more freedom to define and direct their own inquiries.

There is no single design protocol for IBL, but the point of departure typically is a question, whether formulated by students, teachers or others, or by negotiation amongst them. Questions may be generated from intriguing fieldwork or design problems, complex real-world case scenarios of relevance to professional practice, stimuli such as visual resources, or more broadly from already-established or new lines of inquiry within a research domain. Design for IBL normally is strongly process-focused even when the intention is to engage students with very specific content, in that it is students' engagement with the inquiry process that drives their activity. A key aim is to design conditions, in which students' inquiries are stimulated and can flourish, and in which students are guided and supported effectively to develop relevant competencies for inquiry (i.e. the scholarly and research techniques of the discipline) and learning skills in areas such as information literacy, reflection, technology use and group work. Designing for IBL involves incorporating the approach into the frameworks of wider curriculum requirements, establishing appropriate learning outcomes and assessments, creating or selecting tasks that will motivate and engage students, selecting or creating learning resources, and planning appropriate guidance and support. Laurillard (2012: 129) identifies the following as key design features of IBL design: negotiation of a task or question that will be appropriate for rehearsing students in the ways of thinking and practising in their field; selection or creation of the resources and task environment to be used by students; scaffolding and progressive 'fading' or decreasing of guidance and support during the inquiry process as students gain in expertise and confidence; provision of opportunities for students to test and adjust their developing skills and knowledge. Much design work for IBL entails planning and reflection prior to the learning activity, but design-in-action is also involved when teachers modulate their designs in response to the activity that takes place.

IBL frequently is seen as a form of active learning in which students carry out research-like tasks to explore and assimilate aspects of an existing knowledge base. But in open inquiry modes, IBL extends beyond learning (understood as individual conceptual change) towards and well into the realms of genuine scholarship, research and knowledge-building (understood, following Bereiter (2002), as a contribution to improved thinking or knowledge in a domain). In light of their research into the student experience of inquiry, Levy and Petrulis (2012) propose three fundamental design considerations for IBL: the epistemic orientation of students' inquiry (learning/knowledge-building); with whom primary responsibility lies for establishing the inquiry question or theme; and, the level and nature

of process support, or scaffolding, to be provided—that is, the guidance, structure and resources aimed at helping students to engage productively with the inquiry process and subject matter. Different approaches to designing progression in IBL through the levels of study include those that lead from 'inquiry for learning' towards 'inquiry for knowledge-building' at more advanced levels, and others that introduce students to open forms of inquiry early, at more introductory levels. Early opportunities to engage in inquiry that is strongly guided and scaffolded but that is open-ended in character, and for students to frame their own inquiry questions, may in some contexts yield significant educational benefits (Levy and Petrulis 2012). Appendix presents a pedagogical planner for IBL that draws attention to these, and other, key considerations for IBL design. Intended as a simple tool for use in practical academic development settings, it is organised as a series of questions for teachers to consider as they engage in the process of design, whether technology-supported or not.

13.4 Designing for IBL with the Learning Activity Management System

How might computer-based tools assist higher education teachers to design for IBL? As noted above, software has been developed specifically to support teacher-designers to create, share and re-purpose designs for learning. As the leading software of this kind, LAMS was selected for a pilot study that aimed to examine the issues raised by such a tool for the development and support of IBL practice. LAMS is an open-source tool that enables design, orchestration and sharing/reuse of sequences of learning activity, placing special emphasis on collaborative and group processes (Dalziel 2003, 2007). It is intended to foster activity-oriented design thinking for activity-focused pedagogy including, but not limited to, IBL; it is important to distinguish a design for learning system such as LAMS from specialist computer-supported inquiry learning software as described, for example, by van Joolingen et al. (2007). The visual, drag-and-drop LAMS design interface offers the user-designer a range of activity types (tasks) and the means to arrange these into sequences and embed, or connect to, relevant content and other tools and services. The designer can see the design from the students' point of view during the process of authoring. Drawing from the activity tools available, a simple LAMS sequence might, for example, start with small group discussion, followed by Web research and resource-sharing, followed by large-group discussion of the results in relation to material provided by the teacher, and end with individual reflection and note-making. Once learning designs have been created in LAMS, they can be run with students, using the same software, published online to a wider community and reused and adapted by others. LAMS has been developed through a number of versions since the study reported here took place using version 1. More recent versions have been oriented towards embedding greater flexibility

into design structures and optional de-coupling of the system's authoring and run-time aspects.

The questions explored by the pilot study were:

- What are higher education teachers' purposes and values in relation to IBL, and what approaches do they take to design for IBL?
- What are the affordances of LAMS as a tool for creating IBL designs, and for stimulating engagement with pedagogical values and practices associated with IBL?

One-to-one and (in one case) one-to-two interviews were carried out with twelve members of academic staff who piloted LAMS, with in addition, a series of focus group interviews involving thirty-nine members of academic staff in total. All but one of the pilot users were university teachers located in arts or social sciences disciplines (Education, Geography, Information Studies, Law, Modern Languages), the exception being from an applied science (Engineering). In predesign and implementation interviews, pilot users were asked to describe how they understood and approached IBL in their practice; how they usually approached designing for learning; why and how they planned to use LAMS in their pilot. Post-implementation interviews explored design and orchestration experiences and outcomes. Focus group interviewees were shown a selection of LAMS sequences that had been produced by pilot users and then asked to respond to a series of questions on topics relating to design for learning in their own IBL practice. In addition, LAMS sequences designed by pilot users were analysed, to identify key design features and patterns.

The study illuminated teachers' differing conceptions of IBL. Some of those who participated in the project aimed to engage students, through IBL, in processes that were very closely aligned with formal, discipline-based research practice. Others saw IBL as a more general process of critical questioning, exploration and investigation, encouraging 'inquiring' students to set their own learning goals, plan and direct their learning and reflect on outcomes. Teachers often identified the development of learner autonomy as central to their pedagogical purposes in adopting IBL approaches, describing themselves as facilitators of learning rather than as teachers or instructors. They most often characterised IBL in terms of open-endedness, providing opportunities for students to pursue different lines of inquiry with multiple possible outcomes. Teachers also emphasised a strong focus on developing students' learning and other transferable skills and metacognition through the process of IBL. However, while the teachers who piloted LAMS all indicated that they aimed to foster learner autonomy, some preferred quite strongly teacher-led approaches whereas others preferred more student-led approaches. They often explained their personal approaches to IBL pedagogy in flexible terms, saying that they would adopt different modes of IBL in different educational contexts.

These teachers typically were unfamiliar with the term 'design for learning' to describe the practice of planning teaching, or curriculum design, in higher education. They had not previously used LAMS or any other any digital design for

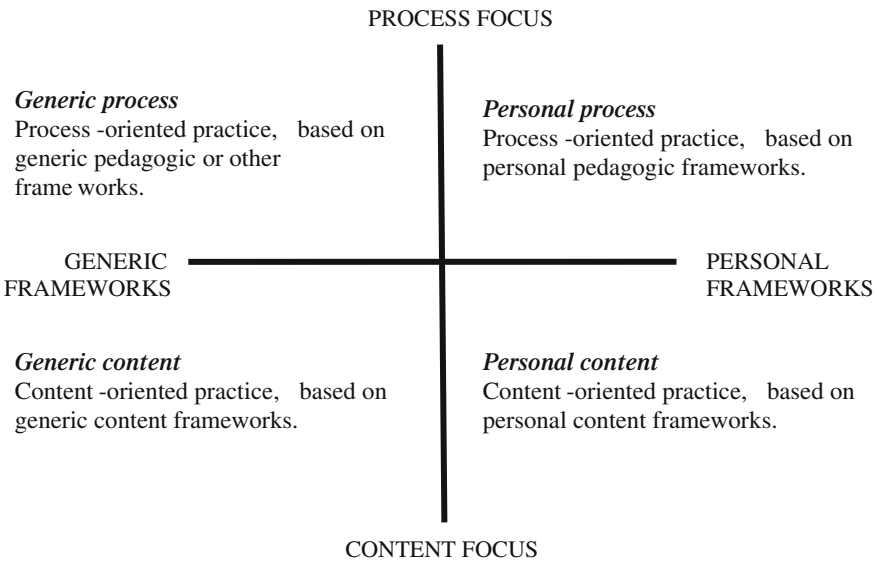

Fig. 13.1 Approaches to design for learning—adapted from Levy et al. (2009)

learning tool. They explained their general approaches to planning teaching as highly contextualised, with specific learning outcomes normally providing an initial point of departure and a wide range of contingent factors taken into account. Within this broad frame, two different dimensions emerged in their accounts of design for learning: a 'content/process' dimension and a 'generic/personal' dimension. The first of these differentiates, on a continuum, between design considerations oriented primarily towards engaging students in a process (activity), and those oriented primarily towards engaging students with content (subject matter). The second differentiates between design considerations that are inflected more by 'generic' pedagogic or disciplinary frameworks and models, and those that derive more from practitioners' own personal pedagogical goals and perspectives. Levy et al. (2009) present these dimensions as a matrix, thereby identifying four distinct modes of design for learning. Figure 13.1 presents an adaptation of this.

The teachers thought of design for learning as a practice with both content- and activity (process)-oriented dimensions. Either of these considerations could dominate their design thinking, although some saw these dimensions as inseparable and in dynamic interaction, and described design for learning as entailing movement back and forth between them. Most, but not all, of the teachers associated IBL with strongly process-oriented design. Some described designing for IBL largely as a matter of drawing on their own personal conceptualisations of the inquiry processes or content (subject matter) with which they wanted their students to engage. Others described drawing on different types of external, or generic, framework. Generic 'process' frameworks were revealed in descriptions of design

as the creation of sequences of learning tasks based on standard procedures embedded in disciplinary or professional practice, for example, when the task-sequencing elements of design were identified as a matter of 'step a' necessarily needing to be followed by 'step b' and so forth. None of these teachers described applying specific pedagogic models, such as Kolb's (1984) experiential learning cycle, Laurillard's (2002) conversational framework, or Garrison and colleagues' Community of Inquiry framework (Garrison and Arbaugh 2007). Generic 'content' frameworks were revealed in teachers' descriptions of design as a matter of planning the sequence of presentation of one topic after another, in line with generic knowledge structures of their discipline.

How were these approaches to design thinking affected, if at all, by the use of LAMS, and what were its affordances found to be, as a tool for supporting the development of IBL design? Affordances have been described as 'features perceived by an observer [that] create the possibility for a certain kind of behaviour' (Laurillard et al. 2000: 3). As outlined below, three main themes emerged in relation to these teachers' experiences of designing with LAMS: its support for rapid process design; for linear inquiry pathways; and for tight structure and teacher control.

Rapid process design: Pilot users did not approach experimentation with LAMS with the aim of implementing new approaches to IBL. Instead, they focused on ways in which use of the tool might fit with, and enhance, their existing approaches to IBL. Several used the tool to broadly replicate designs they had already used in face-to-face teaching, while others had new ideas sparked for small-scale inquiry tasks. Comparing LAMS with the university's VLE, some felt it moved the focus away from overloading with content and considered that this helped foster process-oriented approaches to design that they saw as more compatible with IBL. They usually described designing with LAMS as an iterative process in which it was very easy, for both less and more experienced learning technology users, to rapidly build up and change the sequence of tasks and to populate them with relevant content, links and instructions. In principle, they welcomed the possibility of reusing LAMS designs created by others, especially for cherry-picking inspiring design ideas for adaptation to their own subject teaching or for easy, off-the-shelf adoption of full sequences for teaching in generic skills and subject areas. However, in practice, these pilot users did not normally look at others' designs before creating their own. Although design with LAMS was perceived as quick and easy, some pilot users described experiencing their own initial responses to the system as mechanistic and unreflective. They emphasised the value of pedagogical reflection, discussion, guidance and exemplars in conjunction with experimentation with the new system. Custom-designed sequences used in introductory workshops provided a starting point for critical and reflective discussion. Dialogues that took place with academic development staff and other practitioners around the use of LAMS were identified as positive developmental stimuli, in particular, in making the concept of design, and task design, more explicit.

Linear inquiry pathways: All teachers saw 'linearity' as the principle characteristic of the way in which LAMS supported—and shaped—their design thinking

for IBL. They experienced a strong sense of LAMS as a tool for creating and reinforcing linear learning pathways and saw this as either positive or problematic, depending on different pedagogical purposes and context. On the one hand, they welcomed these characteristics as a means of reinforcing sequential inquiry processes and procedures. Teachers were especially likely to see advantages in using the tool to support activity in subject areas—such as Engineering, Information Technology, Languages, Maths, Nursing—in which 'generic' inquiry processes could easily be identified. They saw LAMS as especially suited to the design of bite-size task sequences that would scaffold students' engagement with larger, more complex inquiry processes. On the other hand, teachers saw linearity as problematic in relation to 'messier', iterative, more personal forms of inquiry. From this perspective, the design functionality of LAMS was perceived to be conducive of something akin to programmed learning or training. For example, the version used in the pilot did not allow easily for backwards as well as forwards movement through sequences, and 'branching' options to facilitate the creation of multi-level, in-parallel activity sequences were not yet available. These were seen as major problems by those teachers who approached IBL as a fundamentally iterative and 'parallel-processing' experience. Others saw the linearity of LAMS sequencing as imposing a serialist rather than holist learning style (Pask 1976), or as incompatible with the learning approaches of specific groups, such as postgraduate professionals. The value of LAMS in this version as a tool to design more complex, holistic, personal and extended inquiry processes, therefore, was questioned. Some teachers welcomed the prospect of the enhanced design features of the next version of the software as more promising for IBL, because of its greater potential for enabling iterative and multiple activity pathways through a task sequence.

Tight structure and teacher control. In general, teachers experienced LAMS as a tool for designing tight activity structures with relatively high levels of teacher guidance and control. They often identified tight structure as a positive feature in the context of introductory forms of IBL. However, the perceived in-built bias in the system towards tight activity structures was felt to be against principles of open-ended inquiry and higher-level student autonomy. Teachers questioned the extent to which the tool could help them facilitate students' ownership of their inquiry process. Some pilot users explicitly identified LAMS with behaviourist or didactic approaches to teaching, and analysis of the pilot sequences confirmed that LAMS was not used by these teachers to create strongly student-led, open-ended or extended approaches to IBL. Instead, the sequences generally were designed as small-scale initiatives in more teacher-led approaches to IBL. However, while perceptions of LAMS as affording tight activity structure and teacher control were generally to the fore early on in exposure to the tool, teachers' initial perceptions could shift over time. Moreover, some interviews and focus group discussions mooted the idea of 'students as designers' and of giving students opportunities to use LAMS to (co-)design their own inquiry activities. Teachers envisaged setting tasks designed to empower students to take greater control of their inquiries, whereby one group of students might design a sequence for another group, or staff and students would work collaboratively on design for learning.

13.5 Implications for Academic Developers and the Development of Digital Design Tools

This research reviewed above revealed aspects of higher education teachers' pedagogical values and purposes in relation to IBL and two main dimensions of their design for learning practice, labelled here as a 'content/process' dimension and a 'generic/personal' dimension. Teachers tended to associate design for IBL with relatively strongly process-oriented approaches, drawing on either more 'generic' or more 'personal' process frameworks to guide their design practice, as illustrated in the two upper quadrants of the matrix in Fig. 13.1. In foregrounding differences of emphasis in teachers' accounts of how they approach design, the matrix offers a conceptual framework that may be useful for further explorations of the nature and practice of design for learning in IBL and other pedagogical contexts, across different disciplines.

The research also highlighted pedagogical and design affordances of one tool, LAMS, in relation to IBL, as reflected in practitioners' responses to it. In the context of this study, for teachers with varying levels of familiarity with IBL, the features of LAMS offered similar design affordances: rapid process-oriented design practice; design approaches based on linear learning pathways; and design approaches based on relatively tight task structure and sequencing, and teacher control.

The study pointed to the potential value, for IBL design and development, of generic tools that can bring the concept of design for learning to the fore and support the practice of process-focused design. LAMS was perceived to be promising for some forms of IBL in a range of disciplinary contexts. However, it has been suggested that a margin of 'indirection' in teaching-as-design is important when development of student autonomy is desired (Goodyear and Ellis 2007). The characteristics of LAMS in the version used appeared less well-suited to flexible, open-ended and student-led forms of inquiry. These considerations suggest that for IBL, there will be value in developing design tools that provide for a high level of flexibility in relation to pedagogical choices about the extent of structure and control of students' inquiry processes, so that the balance of constraint and freedom may easily be adjusted by teacher-designers to suit the circumstances of different educational contexts, including different disciplines and levels of study. The project also suggested that technology-based design may bring a risk of engaging a somewhat mechanistic response. While wanting tools that would be easy to use, teachers were concerned about a reductive impact on practice. This reinforces the importance of supporting teachers to 'step back' during the design process to explore underpinning pedagogical purposes and values, for example through interactions with academic developers and peers, and provision of pedagogical guidance resources.

The potential of LAMS was not fully explored in the study, since the focus was on initial encounters and experiences of the tool rather than longitudinally on experiences over time. However, as Masterman and Lee (2005) also found, use of

the tool per se was not associated with strong developmental impact. In particular, it was shown here to have (in version 1) little articulation with, or stimulus for, ideas, values and practices that represent arguably the most empowering forms of IBL pedagogy (Hutchings 2007). Nevertheless, a generic design for learning system such as LAMS may well have potential to facilitate the design of more transformational forms of IBL. The fact that LAMS in the version piloted did not tend to orient pedagogical thinking and practice in the direction of strongly student-led pedagogies is not only a consequence of its features but also of the pedagogical mindsets and other factors brought to bear on its use. Affordances are relational and context-sensitive, rather than inherent. As observed in the study, when teachers had opportunities for pedagogical reflection and discussion, they did identify ways in which LAMS task sequences might be designed to encourage empowering modes of IBL. The study illustrated the importance of teachers with interests in IBL having exposure to a wide range of exemplar designs, including designs based on loosely structured and student-led approaches.

The project reviewed here explored design for learning mainly from the perspective of the teacher-as-designer. However, in the context of IBL, which places emphasis on learner autonomy, it would be useful to explore how students themselves might use design for learning tools and to investigate the issues relating to this. For example, is there a case, as is suggested by Levy et al. (2009), for the development of explicitly 'student-facing' digital tools that assist students to design, manage and adjust their own inquiry processes, and to use design representations as resources for reflection and sharing with peers, thereby supporting metacognition? If so, the findings of the study reviewed here indicate that such tools would need to include highly flexible research planning features, and perhaps offer integrated guidance on design for learning from the student perspective. The kinds of tools envisaged would also serve to support the development of students' digital literacies for learning in the fast-moving digital resource environment of contemporary higher education.

13.6 Concluding Remarks

Technology-supported design for learning tools and environments offer support for the development of professional practice in higher education teaching and a means for teachers to participate in sharing and refining good practice within professional communities. Interest in teaching-as-design, and in using digital technology to capture, represent, reuse and share pedagogic design ideas, including in the form of structured 'design patterns' as well as individual learning designs, is growing (Goodyear and Retalis 2010; Laurillard 2012). Laurillard envisages teaching communities in which teachers 'enact design science as part of their normal professional practice, and have the means to act like design researchers themselves, i.e. documenting and sharing their designs' (2012: 7). Recent initiatives in the UK include the development of Cloudworks, a social software environment for

community-oriented learning design sharing and reuse (Conole and Culver 2010), and the development of the learning design support environment (LDSE), which includes an interactive support environment called the Learning Designer that interfaces with LAMS (Laurillard et al. 2013).

The concept of design for learning emphasises the role of activity in the experience of learning and of task design in the practice of teaching-as-design. The research reviewed in this chapter highlighted the potential value of easy to use digital design tools in helping to generate and share creative designs for IBL. The study discussed in this chapter was small-scale and exploratory, and so there is a need for further work to test its findings and implications. However, it suggested a number of considerations for academic developers and for developers of computer-based design for learning systems. These include the risk of fostering inflexible or mechanistic conceptions of inquiry, teaching, and learning, and the need for design tools, and associated community and institutional processes, which help to engage teachers in imaginative and critically reflective approaches to development and innovation in their professional practice.

Appendix: Inquiry-Based Learning Pedagogic Planner (Adapted from Levy et al. 2010)

Designing for IBL	Questions for the teacher-designer to consider
Intended learning outcomes	• What are the intended learning outcomes of this inquiry?
	• Will students use inquiry solely to engage with existing knowledge ('inquiry for learning') or also to generate, potentially, new ('inquiry for knowledge-building')?
	• What will be the balance between subject-matter outcomes and process outcomes (e.g. inquiry process competencies)?
	• Will students play a role in determining learning outcomes?
Students	• What relevant subject and process knowledge and skills will students bring to the inquiry? How do they understand inquiry and research in their discipline, and their own roles as student researchers?
	• How might IBL challenge them, e.g. in relation to their beliefs about their role in learning and knowledge-building, their self-confidence, and their existing subject-matter knowledge and inquiry skills?
	• What are their likely needs for support and guidance, in relation to both subject matter and the inquiry process?
Inquiry theme	• What will students explore? How will their inquiry relate to the curriculum?

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Designing for IBL	Questions for the teacher-designer to consider
	• Will there be a link between students' inquiries and their academic teachers' research interests? If so, will this link be made explicit?
Inquiry question	• What will the stimulus be for the inquiry (a question; a scenario; a problem; an image; an artefact; a discussion; something else)?
	• Will the question be open-ended, or is the answer already known (to the teacher)?
	• Who will establish the question—the teacher, students, someone else?
Inquiry process	• What is the appropriate scale and timescale of the inquiry?
	• Will the process be tightly or loosely structured? A step-by-step sequence of activities, or a more flexible, emergent process? More strongly teacher-, or student-designed?
	• Will students have choices in deciding how to approach the inquiry?
	• Will an established pedagogic framework or protocol be used to structure the process? How closely will it follow the pattern of research practice in the discipline?
Tasks and sequencing	• What tasks will students carry out? How will they be sequenced?
	• What tasks will there be to help students engage with relevant theory/subject-matter (e.g. reflection; discussion; peer-to-peer information sharing; lectures; practical workshops; laboratory sessions)?
	• What tasks will there be to help students develop process competencies relating to their inquiry (e.g. in areas such as research methods, information literacy, group work, reflective writing, use of technology)?
Summative assessments	• What will be assessed (e.g. understanding of subject matter; inquiry understanding and competencies)? What will the assessment criteria be? Will students play a role in establishing these?
	• What form will assessed outputs take (e.g. completed worksheet; quiz; computer model or simulation; essay; report; film; poster; wiki; product design; journal article; other)? Will students play a role in deciding on outputs? Will assessment be of individual or joint/team work?
	• Who will assess (teacher; student peers; self-assessment; other)? How will summative feedback be given?
Information resources and technology, and other equipment	• What are the essential information/learning resources, equipment and other technology that students will need to conduct this inquiry?

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Designing for IBL	Questions for the teacher-designer to consider
	• How will students access relevant information? What will be the balance between providing information to students and requiring students to seek and select information independently?
	• Will students be guided towards information on process issues and skills as well as subject matter?
Spaces	• Is there a need for a particular type of learning/teaching space during and outside of teaching 'contact' time?
Guidance and scaffolding	• How much guidance and scaffolding will there be, and will these be reduced as students become more experienced?
	• Who will be involved in guiding and assisting students (teachers; mentors; learning support professionals, e.g. librarians, technicians)? What will their roles be?
	• How and when will formative feedback be provided (e.g. by teacher, computer software) and at which stages in the inquiry process?
	• Will there be an element of partnership between students and teachers or others?
Peer to peer	• Will students work together? If so, when and in what way? Will there be a focus on building an 'inquiry community'?
Communication and dissemination	• Will students share the results of their inquiries with each other? More widely at department or Faculty level, or with a community beyond the university or college?
	• How will results be shared (on web, at an event, via presentations, posters, suitable peer-reviewed outlets, other)?
Design and evaluation	• How will you go about designing this IBL initiative? Will you use a design tool to assist with planning? Will you look at other teachers' learning designs for IBL and reuse or adapt them? Will you involve students as designers?
	• When you have developed and run this initiative, will you evaluate its effectiveness? Will you share your design, and experience, with other teachers?

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