Innovation in University Computer-Facilitated Learning Systems: Product, Workplace Experience and the Organisation

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Declaration

This is to certify that:

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Signed

Paul Fritze
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Summary

This thesis reports on the development of a generic online system to support learning and teaching at the University of Melbourne. New online technologies, the fostering of innovation at national and university levels and my position within a central educational unit provided the opportunity in 1996 to adapt a previous software package for online use. My observations of the problematic nature of computer-facilitated learning (CFL) production led me to take an open approach to the development, seeking both a practical product and enhanced understanding. A series of formative questions defined the scope and goals of the study, which were to:

- produce a generic online learning system;
- increase understanding of the workplace experience of that development; and
- develop an organisational model for the further development of generic CFL systems.

Given this multi-disciplinary focus, many paradigms in the literature could potentially have guided the study. A number of these aligning with the research purposes, context and constructivist philosophy of the study, were reviewed from the perspectives of learning, CFL development and the organisation.

Literature on student learning informing the study included Laurillard’s Conversational Framework of activities necessary for academic learning and Biggs’ presage-process-product model, the latter emphasising the link between a student’s perceptions, learning approach and learning outcomes. From a CFL development perspective, models reflecting a constructivist view acknowledge complexity and real life settings, emphasising the need for participatory involvement and evolution of approaches. These themes were drawn together into a pragmatic guide for developing user-active learning and teaching environments. From the organisational perspective, universities face a challenge to maintain the strength of their collegial expertise, while maximising knowledge flow within the institution. Argyris and Schön’s organisational learning theory and an extension of the Conversational Framework to the university context were examined as relevant models of a learning organisation. Problems reported with the uptake of CFL innovations were examined through models of organisational diffusion and adoption. Again, from a constructivist perspective, questions of use and adoption were seen to merge with the design process.

The study methodology reflects the open-ended nature of an authentic workplace setting and the adoption of multiple development goals. It is informed by multiple disciplines and there are multiple perspectives that must be accommodated. I adopted Reeves’ mixed-methods pragmatic paradigm as the most appropriate way of dealing with this complexity, drawing on action research and grounded theory analysis.

Development of a generic online system, as the first goal, was informed by an action research prototyping methodology. This involved collaborations with teaching staff in many independent curriculum projects between 1996 and 2000, from which common requirements for a generic system were factored. Over this time, the design made a profound shift from a high-level teaching engine, to a low-level architecture for supporting learning and teaching transactions. Case studies of curriculum use of the emerging Online Courseware Component Architecture (OCCA) were examined in detail and the broader uptake across the University reviewed.

The second goal involved an examination of the workplace experience from 1991 to 2000, using a multi-stranded grounded analysis of data. A narrative history provided a rich chronological account of the workplace...
experience of innovation. This was used to elicit alternative perspectives from stakeholders and to illuminate other strands of the inquiry. Other representations included a quantitative analysis of emerging dimensions, visual maps of phenomena, illustrative case studies and a developer-centred model of innovation.

In the final goal of the study, the empirical evidence was examined from an organisational perspective to synthesise a generalised model of ‘Collaborative Developmental Research’ based on key collaborations between innovative teachers and developers. This model provides a strategy relevant to research-orientated institutions that bridges independent academic research and more systematic production models. It is characterised by stages of exploration, formalisation, iterative prototyping and packaging, supported by the innovator’s network and institutional management.

Based on the evidence from this study, I contend that innovation in generic CFL systems should involve creativity in both educational approach and organisational adaptability. That is, a collaboration between central developers and teaching innovators will align with broader institutional needs better than a localised teaching innovation that is later ‘packaged’ for generic use. This generic quality was demonstrated by the design ‘volatility’ of the OCCA system, which fostered multiple interpretations of its functionality and use. As such, it was shown to provide a framework for academic innovation and sharing of educational components and techniques. Wider exploitation of this potential will require packaging for use in multiple settings and a rethinking of roles for teachers and support staff.

While CFL innovation is often seen to be driven by the ‘lone innovator’, the evidence shows a consistent picture of an innovator working, not in isolation, but within an eclectic horizontal network cutting across formal structures and reflecting the specialist nature of the research. Periods of intense workplace activity and stress were revealed, balanced by an intrinsic interest associated with discovery and community interactions, rather than more formal rewards.

Although the development was informed by an action research prototyping methodology, in the complex pattern of activities emerging this was subsumed by other factors within the real life workplace setting. That is, within authentic workplace activity, generalised theories have no higher status than empirical evidence and are informed by, and inform, emerging understandings. Further, there is a need for routine interpretive research methods to be incorporated into workplace practice to connect organisational strategies and discipline models with the realities of real life experiences. This is the responsibility of both innovators and management. The production and reflection on narrative histories were shown to offer potential for this purpose.

The combined elements of the study provide a unique longitudinal picture of CFL innovation in a university setting that can inform institutional policy, as well as a wider understanding of ICT system design, workplace issues and the processes of organisational innovation and diffusion.
CHAPTER 1. Background and key issues

1.1 Introduction

This thesis reports on the production of an innovative online learning system at the University of Melbourne and examines the workplace experience of the development and the broader organisational context in which it occurred. The inquiry draws on two major case studies of innovative development, occurring over a period from 1991 to 2000. This was a time of significant and rapid change in communication technologies and the higher education environment in general.

In this chapter the setting of the inquiry is examined from a global, national, institutional and personal perspective. It is from this background that the scope of the study is defined by a series of formative questions reflecting contemporary issues associated with real world problems in the workplace. These questions provide the foundations from which the purpose and goals of the study are developed in Chapter 2.

At the commencement of each chapter, a figure is used to indicate its position within the overall thesis structure, which is outlined in Figure 2.2 (p. 22).

1.2 Technology, innovation and change in higher education

The revolution in Information and Communication Technology (ICT) underlies fundamental changes not only in education, but also in broader society. It is changing the way universities are approaching teaching, administration and research, while also revolutionising the working environment that students will enter. The West review of Australian higher education policy noted that:
Developments in information technology have the potential to revolutionise the management processes of universities and the education products that universities provide. Developments such as the Internet and the World Wide Web will create opportunities for higher education institutions to change fundamentally the way that teaching and research are conducted, and to revolutionise the way that they manage their administrative processes.

(CRHEFP, 1997, p. 18)

At the same time, however, universities are experiencing a progressive reduction in government funding, increased competition for students and rising staff-student ratios. Lecturers have to deal with conflicting demands on their time; they must manage larger classes with changing student profiles, while simultaneously maintaining productive research careers. Despite a general expectation that the quality of teaching should improve, research performance remains the key promotion determinant for most academics.

Universities must position themselves in an increasingly competitive national and global educational market, with strategies to cope with immediate requirements and longer-term visions. Just how well traditional university frameworks that have evolved slowly over a century can provide adequate guidance is questionable (Clark, 1998, p. 21; Laurillard, 1993, pp. 3-4; McNay, 1995, p. 114; Ramsden, 1998a, pp. 34-5; University of Melbourne, 1999).

Strategic planning for the integration of ICT into the curriculum should aim to improve learning and teaching and accommodate changing student profiles, while increasing cost efficiencies (Yetton, 1997). The most appropriate infrastructure for such reform will depend on the existing culture and resources of the institution and may reflect an alignment of policy informed from the top or bottom. The Information Technology (IT) policies of the ‘Old’ and ‘New’ universities exemplify two quite different approaches (Yetton, 1997).

The more resource-rich ‘Old University’ tends to foster independent activities of academics to feed the institution with innovations in teaching, learning and research. That is, learning solutions are driven from below, by “academic propriety”, rather than external forces and marketing. As Laurillard (1993) observes:

> Academic values, not accountancy, should guide the direction of reform, albeit within the requirements of financial probity. We need to rebuild the infrastructure that will find the fit between the academic values we wish to preserve and the new conditions of educating larger numbers.

(Laurillard, 1993, p. 4)

The grass roots experiences of teachers ideally progress through the university infrastructure to inform management, so that individual curriculum projects fostered by institutional strategies generate innovative solutions in specific discipline and learning areas. As ‘design experiments’, these can inform central policy, although generalising generic approaches may prove difficult. These projects usually represent the interests of enthusiastic teachers, rather than the majority ‘mainstream’ staff who may have different perspectives on the adoption of new technologies. There is a tendency also for less successful experiences not to be fully reported and the benefits that would otherwise occur are lost (McNaught, Phillips, Rossiter & Winn, 2000, p. 53).
In contrast, the ‘New University’ plans centralised resources and defined core competencies to deliver a standardised quality and reliability to large student numbers. Information flow controlled by systematic and centralised data gathering processes, however, may mean that input from a local level is difficult to incorporate and the infrastructure tends to develop through iterative refinement rather than quantum leaps.

The setting of this study is the University of Melbourne. This is an institution characterised by a culture of research, academic independence and the belief that academic values must underlie educational decisions; it reflects the philosophy of the Old University.

1.3 National strategies for curriculum innovation

Since the early 1990s, national policies in Australia have fostered a climate for innovation in the use of ICT in education. The Committee for the Advancement of University Teaching (CAUT), set up by the Australian government in 1992, established a series of competitive funding programs to “foster and facilitate the development of good teaching practice in universities” (Alexander & McKenzie, 1998, p. 4). ICT was seen as a way of maintaining or even improving quality, while reducing the costs of administration and teaching (Alexander, 1999, p. 173).

The national program continued in various forms from 1993 to 2000 with grants of up to $50,000 being awarded for innovative teaching projects, the majority of which involved computer-based approaches (Alexander & McKenzie, 1998, p. 4). Evaluation of these national funding programs, however, revealed that only one third of the projects funded between 1994 and 1995 reported improved learning outcomes (Alexander, 1999). This was in part attributed to lack of meaningful evidence on learning outcomes due to inappropriate evaluation methods and/or lack of time.

Alexander called for improved professional practice in the management of ICT projects, establishment of a multi-disciplinary team approach, integration of projects into students’ whole course experience and communication of project outcomes to colleagues and academic managers. Properly informed evaluation needed to be incorporated in all stages of development by academics:

…developing their awareness of what is already known about effective evaluation of innovations; thoughtfully choosing evaluation methods to collect valid evidence at different stages of the project and for different purposes; critically analysing and synthesising evidence they have collected; using evaluation findings to inform ongoing changes to the innovation; and communicating about the innovation and its effectiveness to the academic community and the broader society.

(Alexander, 1999, p. 182)

Lack of effective evaluation may be one reason why few ICT innovations are used outside the institution in which they are developed (Alexander, 1999, p. 182). Significantly, none of the reported evaluations looked at “impact on the organisation”. Despite large investment in electronic educational resources over many years and the potential benefits offered by reuse, there is little evidence at a national level of dissemination of resources or pedagogical practices.
In recent years innovation in higher education involving the use of communication and information technologies has proceeded through the framing of projects, devised by enthusiastic individuals, often working in isolation from their colleagues. Funding is for short-term products and evaluation limited to the requirements of a project report produced in a relatively short time frame.

(McNaught et al., 2000, p. 2)

While there are a number of well-designed databases intended to improve the dissemination of CFL resources in Australia, these do not appear to have been widely used (McNaught et al., 2000, p. 172).

1.4 Curriculum transformation at the University of Melbourne

The setting for this study is the University of Melbourne. This is the second oldest in Australia with some 30,000 equivalent full-time students, 2000 academic staff and 2400 general staff in 11 faculties. It is primarily a campus-based institution with a strong research focus and culture of academic independence. Only a few faculty areas are concerned with distance education.

University policy and infrastructure for ICT in education has evolved substantially over the period examined in the study, as depicted in Figure 1.2 (refer to p. 7). The incorporation of multimedia into learning and teaching was first centrally promoted with the release of the Information Technology Strategic Plan (University of Melbourne, 1991). Prior to this in 1990, the Interactive Multimedia Learning Unit (IMLU) was established to support early innovators in faculties with centralised multimedia resources and professional development. It undertook the production of a small number of multimedia projects, evaluated emerging technologies and in 1992, administered a program of ‘seeding’ grants to individual academics for innovative applications of ICT in teaching.

In 1996, IMLU was expanded into the Multimedia Education Unit (MEU), made up of about 20 staff including academics, video producers, graphic designers, photographers and programmers. Neither IMLU nor MEU were intended to become centralised ‘mass production’ facilities; the University’s policy was for faculties and departments to manage their own curriculum development in the longer term.

In 1997, the Teaching & Learning (Multimedia & Educational Technology) Committee (T&L(M&E&T)) was established to advise the Academic Board on ICT policy, encourage and assist faculties, manage funding programs funds and monitor progress. Faculties contributed to the planning process through the T&L(M&E&T) Committee and a Multimedia Coordinators’ reference group. A major influence on the uptake of ICT in the University was the competitive grant program initiated by T&L(M&E&T) in 1997. Over six years, $13M was awarded to over 240 innovative curriculum projects from all faculties. More recently, such projects have encouraged collaborations between faculties and external institutions; greater responsibility has also been given to faculties to manage their own funding and support initiatives.
Progress in the implementation of ICT within the University has been monitored by evaluations of individual projects and reports commissioned by T&L(M&ET). An external report in 1998 indicated the requirements of an infrastructure necessary for sustaining the process of cultural change (J. Taylor, 1998). It emphasised the role of ‘technology-use mediation’ by central educational units, such as MEU, so that technology could be shaped within the contexts of different faculties. A later survey indicated that undergraduate students felt that both interactive applications and the simple provision of online information helped them learn effectively (James, 2000). More recently, a study of over 80 evaluation publications and reports produced in the University revealed a wide variation in educational and evaluation approaches across the institution, reporting improvements in learning outcomes that ranged from ambiguous to modest (Fritze, 2002). Most problems reported related to the integration of initiatives into existing curricula and difficulties associated with the changed expectations of students. The full impact of the T&L(M&ET) funding program and the extent of re-use of developments were difficult to determine.

In addition to the centrally supported T&L(M&ET) funded projects, the faculties also provide localised skills, resources and academic support, tailored to specific discipline requirements. For example, the Faculty of Medicine maintains a specialist unit supporting problem-based learning in Medicine, while another unit in the Faculty of Arts supports computer aided language learning.

Although falling outside the period of the study, Figure 1.2 shows that the MEU, University Library and Information Technology Services were amalgamated into the Information Division in 1999, under the control of
a new Deputy Vice Principal (Information). The Division then consisted of some 400 staff, organised into five main support departments:

- Teaching, Learning & Research Support (TeLaRS);
- Systems & IT Infrastructure (specialised systems, integration);
- IT Strategies & Developments (Emerging Technologies);
- Information Resources Access (information access, archives and digital collections etc.); and
- Client Services (branch libraries).

1.5 Personal background

The two major case studies examined in this thesis involved the development of TutorialTools (1991–4) and a generic online learning system (1996–2000). These are indicated by the shaded areas in Figure 1.2. My own background in relation to these developments is outlined below.

In the early 1990s I worked in the School of Chemistry as a programmer and later instructional designer. It was here that I developed the ‘TutorialTools’ Computer Aided Learning (CAL) software. This was a HyperCard program that enabled lecturers to ‘author’ and deliver interactive tutorials (Appendix 3, p. 275). Briefly, it provided:

- an extensible set of question styles, including multiple choice, short answer, drag items and sort items;
- different levels of immediate feedback with hints, explanations and suggested answers;
- a scripting language used by lecturers to author, edit and transfer questions; and
- logging and reporting tools to monitor and evaluate student progress.

The program was extensively used between 1993 and 1999 to support CAL workshops run to a large undergraduate student body. The team behind this development was awarded major national CAUT grants in 1994 and 1995 and the Chemistry modules were adopted in a number of other Australian universities. In 2000 the School independently developed an online version of the software using the same instructional model so that the extensive body of content material could be reused (Coller & Tregloan, 2001).

At the end of 1994, I transferred from Chemistry to the centrally located Interactive Multimedia Learning Unit (IMLU). As manager of the Multimedia Laboratory, I was involved in academic staff support, educational design, multimedia production, programming, evaluation and investigation of the emerging educational technologies.

In 1996 IMLU became the Multimedia Education Unit (MEU) and with the Web starting to take off, I commenced development of a ‘generic’ online version of TutorialTools, originally titled ‘Tutorial Engines’. This was to be centrally supported and would provide:

- a variety of engaging learning activities;
- a modular structure accommodating alternative approaches to learning and teaching;
- a low entry point to adoption by teachers;
- a range of administrative and reporting tools;
• the ability to share and extend components across disciplines; and
• a collection of evaluated exemplars of successful incorporation into courses.

It quickly became evident, however, that the development was a significant undertaking. Not only were major changes unfolding in online technologies, but also my increasing involvement with different discipline areas revealed widely different educational approaches.

The development of this generic online system over the period 1996–2000 while I was working in the MEU is the principal research activity of this study.

1.6 Conceptual starting point for the study

My role as an instructional designer within a departmental setting shaped my initial understanding of CFL systems development. I conceived this as a professional activity consisting of an iterative process of design, development, implementation and evaluation (see Figure 1.3, p. 10). Activities, such as instructional design, programming, teaching and course design, were linked with particular outputs, such as learning objectives, strategies, questions and assessment items (Fritze, 1996a, pp. 141-2).

I did not see the model in Figure 1.3 as a simple step-wise process, but one involving multiple iterations and time scales. The student learning experience, for example, was reflected back into both instructional design and course coordination activities on a weekly or semester basis. This informed teaching practice, curriculum program and CAL software design. Computer systems also could be used to facilitate certain aspects of the process, for example, by streamlining ‘authoring’, course delivery and reporting. I noted that the alignment of ‘activities’ with individual roles often proved problematic. For example, an individual teacher might take on the multiple roles of course design, teaching and evaluation, with few formal ‘outputs’ being visible to others.

External to the core development and implementation activity carried out in the department, support for CFL technology development, IT, professional development and educational research was offered by central support units like IMLU or MEU, ITS and CSHE, although these had little impact on the day-to-day development.

At a still broader level, Figure 1.3 indicated four higher-level considerations that might underpin decisions:
• the broader needs of the institution and wider society;
• theories about educational design;
• opportunities brought about by new technologies; and
• the individual needs of the learner.

This generalised model of CFL development was my attempt to rationalise the departmental workplace experience at the commencement of the study and marks my conceptual starting point.
My understanding of CFL development at the commencement of the study was influenced by my discussions and work with teachers and others and was articulated in various papers and communications. These views are represented in Table 1.1 as various open-ended ‘formative’ questions that I raised at the time, from which the purpose of the research will be established in Chapter 2 (Fritze, 1996a, p. 212).

Figure 1.3 Conceptual model of CFL development

Boxes: activities, rounded boxes: computer-supported processes (after Fritze, 1996a, p. 142)

1.7 Formative questions of an authentic setting

My understanding of CFL development at the commencement of the study was influenced by my discussions and work with teachers and others and was articulated in various papers and communications. These views are represented in Table 1.1 as various open-ended ‘formative’ questions that I raised at the time, from which the purpose of the research will be established in Chapter 2 (Fritze, 1996a, p. 212).
Table 1.1  Formative questions characterising the ‘authentic’ setting for the study

- Why do the intensive efforts of generally intelligent and caring staff, not to mention significant money, often fail to impact on the learning as intended?
- Why do successful developments of individuals lapse, or fail to be fully implemented by the institution?
- Why is the ‘not invented here’ philosophy so strong when it comes to re-using the efforts of others?
- How can educational technology trigger a true revision of teaching and learning, rather than being treated as an add-on?
- Only a small percentage of staff appears willing to rethink course design – how can the others be involved?
- Project evaluation is generally accepted as necessary but usually undertaken in a token manner and rarely acted upon?
- How do we keep pace with technological developments – things go out of date before they are completed?
- How can innovative technology-based learning frameworks be made possible?
- How can teachers put more work into teaching when they are under increasing pressure to take on new students and undertake more research?
- What actually happens in project developments and how does this relate to what is formally represented?
- What are strategies that support the development and implementation of innovative instructional learning frameworks?
- How do roles and perspectives of participants change?
- How is software made scalable and interoperable, that is, able to be adopted into wider use and integrated with other software?

An investigation into any one of questions in Table 1.1 could be a research study in its own right. Taken as a whole, however, they symbolise the broad concerns associated with the ‘authentic’ setting of this study, which will shape the purpose of the research. This authentic setting encompasses the institution, workplace units and individual roles mapped in Figure 1.3, where clearly no single discipline area is likely to offer complete guidance.

It is an assumption of this study, therefore, that the success of any CFL development will be influenced, not only by educational and technical designs, but also by the understandings and expectations of individual participants, the institutional politics and manner in which a development is integrated into the curriculum (Fritze, 1996a, p. 141). Determination of success will depend on the perspective of the beholder, but should consider wider costs of production, longer-term maintenance, adoption by others, and so on. Attempting to treat this situation by simplifying and testing hypothetical theories or models of practice would be unlikely to address the realities of the specific workplace setting.

1.8  Summary

In this chapter, I outlined the broad background to the CFL development environment in which this study was undertaken. This was a period of rapid change in higher education, when universities were adjusting to increasing competition and changing demands in teaching, while at the same time, information and communication technologies were revolutionising approaches to education and the working environment itself.

Different institutions will adopt different strategies for change depending on their existing culture and resources, but the notion that learning solutions should be driven from below by academic enterprise, rather than through standardised delivery from centralised resources, remains an ideal for many institutions. National policies in
Australia have fostered such a climate for innovator-driven improvement in learning and teaching, although the effectiveness of individual projects and take up outside the originating institution has not been clearly established.

The University of Melbourne, as a traditional research-based institution, has also encouraged innovation in the use of ICT in teaching through the establishment of central and faculty support units and a major competitive funding program targeting individual teachers. The fostering of innovative curriculum projects is thus seen as an important strategy for both producing ICT-based curriculum materials and for contributing to policy formation within institutions.

My own background in ICT began within a departmental setting working as a programmer and instructional designer in the early 1990s. At this time, I developed a successful tutorial program called ‘TutorialTools’ in conjunction with teachers, which was supported by a number of national and institutional funding grants. By 1996, I had moved to the central Multimedia Education Unit and, with the growing importance of the Web and a role to investigate emerging technologies, I began the development of a ‘generic’ online version of TutorialTools for use by all faculties. This development project is the major subject of this thesis.

At the start of the study in 1996, my professional activity model of CFL development reflected my background in a single department and in instructional design. It became apparent that the broader university setting and CFL systems development task represented a complex system for which no single professional discipline could provide complete answers. A series of ‘formative questions’ raised at this time characterised an authentic problem and environment, which will be used to clarify the mission and specific goals for the investigation in the next chapter.
CHAPTER 2. The purpose and scope of this investigation

Background

1.2 – 1.5 National, institutional and personal setting  
1.6. Conceptual starting point for the study

1.7 Formative questions raised

Research mission and goals

2.3.1 Action goal: Production of a generic CFL system

2.3.2 Interpretive goal: Understanding the workplace experience

2.3.3 Developmental goal: An organisational model

Review of literature

3.2-3 Definition of the field of inquiry: CFL Systems Development

Figure 2.1 Contribution of Chapter 2 (bold) within the thesis structure of Figure 2.2

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2.1 Introduction

This chapter outlines the purpose and goals of the study, which aims to address an ‘authentic’ problem directly associated with my workplace activity in the Multimedia Education Unit at the University of Melbourne. The University setting reviewed in Chapter 1 provided an opportunity in 1996 to adapt a previously developed software package into an online learning system for wider use across the University. This is an applied research inquiry that seeks a pragmatic CFL development approach suited to the particular institutional setting and responsive to the changing technical and educational environment.

The broad mission of the undertaking is supported by institutional policies and my position responsibilities. The specific research goals acknowledge the broad context of the workplace environment and are reflected in the ‘formative questions’ about the problematic nature of CFL development I raised at the start of the study. Three research goals are identified, providing a triangulated approach to the study and underpinning the choice of research methodology.

2.2 Mission of the research

The policy of the University in 1996 was to achieve “full integration of multimedia and educational technology into teaching and learning” by the year 2001 (Gilbert, 1996, p. 1). Departments were “strongly urged to seek
advice at the planning stage from staff in the newly-structured Multimedia Education Unit, or faculty-based multimedia units, who can provide technical and educational advice and services.” My own role was associated with the stated aims of the Unit: to “engage in the design, production, implementation and evaluation of strategic multimedia projects…”; “to introduce and foster rigorous research on educational design…”; and to research topics such as the “development and testing software frameworks for the delivery of teaching & learning materials” (University of Melbourne, 1996, pp. 17-18).

A combination of institutional strategies, opportunities afforded by new Web-based technologies and my existing knowledge and experience, therefore underpin the fundamental mission of this research:

_to facilitate the transformation of learning and teaching within the University of Melbourne by developing and implementing a generic online system, meeting the requirements of teaching staff across the faculties._

Potential stakeholders in this study include:

- academic teachers from all faculties interested in face-to-face interaction with students, development of discipline resources and the administration of teaching;
- educational developers and designers producing curriculum materials, centralised learning systems and other resources for faculty users;
- educational researchers and evaluators seeking to enhance understanding of the CFL experience;
- organisation management staff providing centralised support infrastructure, staff development and strategies to improve CFL; and
- students using CFL materials within the curriculum.

My own role in the study varies from educational consultant, developer, designer, researcher to project manager. It involves various levels of collaboration with teaching staff and workplace colleagues.

### 2.3 Research goals of the study

The general mission of any study will inform the establishment of relevant research goals. Lack of clarity of such goals and the failure to distinguish between these and research method have been identified as a fundamental concern of instructional technology research (Reeves, 2000, p. 5). Research goals reflect the investigator’s philosophical stance, research training and the accepted research paradigms within a field. In contrast, research methods are tools that can be employed to tackle the particular research questions. Only once the goals and the nature of the research questions are clear, can appropriate methodology and methods of analysis be selected. Reeves identifies six major classes of research goal commonly pursued by instructional technology researchers (Reeves, 2000, pp. 6-7).

_Theoretical goals_ are concerned with the ordered synthesis of theories or principles that bring together outcomes of other forms of research. Research of this type is relatively rare given the scale of the long-term scholarly agenda required for such levels of generalisation and synthesis.
**Empirical goals** are concerned with how education works, by testing theories in some controlled experimental (or quasi-experimental) situation. Research of this type has dominated instructional technology for decades.

**Postmodern goals** question the assumptions behind educational practices, programs and the social system in which they operate. Such goals require the deconstruction of power structures, political agendas and social conditions of interest groups. Instructional technology studies with such goals have no strong tradition and there are few scholarly outputs for publication.

**Action goals** result in the description and improvement of particular programs or products in particular settings. There is no intention to build a theory or model that could be applied in other circumstances. Such goals can be the basis of legitimate research if reports can be shared with a wider audience who may draw inferences for their own circumstances in a similar manner to interpretivist research.

**Interpretivist goals** focus on descriptions and interpretations of phenomena to portray how education works. Such qualitative investigations have been criticised for their lack of generalisability outside the immediate situation.

**Development goals** maintain a dual focus on developing creative approaches to particular problems while establishing generalised design models to guide future development practice. Research supporting such goals has been referred to as ‘design experiments’, ‘developmental research’ or ‘formative research’. Developmental research focuses on “complex, innovative tasks for which only very few validated principles are available to structure and support design and development activities” (Van den Akker 1999 in Reeves, 2000, p. 7).

Research methodology will be examined in more detail in Chapter 7, but it is worth noting that a one-to-one relationship between the type of goal and most appropriate research method should not be assumed, although certain methods may commonly be associated with particular goals. For example, action goals typically would use an action research approach; however, they might also benefit from quantitative data analysis for certain aspects of a study.

Within this research goal framework, I have adopted a ‘Development goal’ of applying creative approaches to specific CFL requirements, while seeking a generalised cross-faculty solution and understanding of the development process itself. By remaining open to the broader questions of workplace context, this potentially complex undertaking will involve stakeholders in roles not clearly defined. It will bring together perspectives from different professional areas, such as educational design, organisational management and software engineering, with no single discipline model for guidance.

This workplace complexity was embodied within the formative questions introduced in the previous chapter (Table 1.1, p. 11). An analysis of the text of these statements uncovered certain areas of research interest. These areas were compared against practical workplace opportunities and organised under three broad *research purposes*: production, understanding and organisational action. This breakdown is summarised in Table 2.1.
Table 2.1 Dimensions emerging from the text of the formative questions raised in Section 1.6

<table>
<thead>
<tr>
<th>Elements of the formative questions</th>
<th>Research area</th>
<th>Research purpose and goal</th>
</tr>
</thead>
<tbody>
<tr>
<td>“rethinking course design” “innovative [instruction]”</td>
<td></td>
<td>1. Production [technology] rarely acted upon [evaluation] interactivity of the curricula</td>
</tr>
<tr>
<td>“evaluation” “project developments” “research” “take on new students” “teaching”</td>
<td>Learning</td>
<td>To produce, in collaboration with academic users, a generic online system to facilitate implementation of innovative curriculum materials within the University</td>
</tr>
<tr>
<td>“scalable and interoperable” “innovative instructional learning frameworks” “integrated”</td>
<td>Professional</td>
<td></td>
</tr>
<tr>
<td>“intensive efforts” “intelligent and caring” “under increasing pressure” “roles” “perspectives”</td>
<td>Technology</td>
<td></td>
</tr>
<tr>
<td>“the ‘not invented here’ philosophy” “acceptance of project evaluation” “[evaluation] rarely acted upon”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>“small percentage of staff willing [to rethink course design]” “[technology seen as an] add-on”</td>
<td>The individual</td>
<td>2. Experience and understanding To develop understanding of the actual processes and workplace experience behind the development</td>
</tr>
<tr>
<td>“pace [of technological developments]” “[technologies] go out of date” “true revision [of T &amp; L]”</td>
<td>Cultural</td>
<td></td>
</tr>
<tr>
<td>“what actually happens?” “what is formally represented?”</td>
<td>Changing</td>
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<tr>
<td>“significant money” “how can the others be involved” “how do we keep pace with technological developments” “how can innovative technology-based learning frameworks be made possible” “how is software … adopted into wider use” “what are strategies [for] instructional learning frameworks” “re-using the efforts of others” “how can [ICT] trigger a true revision of teaching and learning” “fail to be fully implemented” “fail to impact on the learning as intended” “things go out of date before they are completed”</td>
<td>Reflection</td>
<td></td>
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<tr>
<td>Three goals emerged that were congruent with the mission and purposes of the inquiry:</td>
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<tr>
<td>1. to produce, in collaboration with academic users, a generic online system to facilitate implementation of innovative curriculum materials within the University;</td>
<td></td>
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<tr>
<td>2. to develop understanding of the actual processes and workplace experience behind the development; and</td>
<td></td>
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<tr>
<td>3. to develop an institutional model supporting on-going development and implementation of CFL materials and support systems.</td>
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</table>
Reeves describes the research characterised by such goals as ‘use-inspired’, ‘developmental’ or ‘design experiments’:

- addressing complex problems in real contexts in collaboration with practitioners,
- integrating known and hypothetical design principles with technological affordances to render plausible solutions to these complex problems, and
- conducting rigorous and reflective inquiry to test and refine innovative learning environments as well as to define new design principles.

(Reeves, 2000, pp. 8-9)

While these goals are not the only way of approaching the inquiry, they represent individually significant undertakings that together form a triangulated approach to an authentic workplace problem.

2.3.1 Goal 1: Production of a generic online learning system

Learning requirements, professional techniques and technology

Within Reeves’ framework, the production aspect of the study can be viewed as a specific ‘Action goal’. That is, the intended outcome is a particular software product meeting a defined need for a particular audience. This is concerned with the application of technology and professional methodology to meet identified learning requirements. While this task might be viewed simply as professional practice, I will argue in Section 7.4 that this can be seen as a research undertaking, best approached through an action research methodology.

This goal capitalised on the phenomenal growth of the Web at that time and the opportunity to further develop the ‘TutorialTools’ software, which had proved very successful within a single department (see Section 1.5). In 1996 it seemed relatively straightforward to re-develop TutorialTools for use on the Web, so that:

(a) the software would operate online rather than as a stand-alone package;
(b) the learning functions would be extended to meet the requirements of all disciplines; and
(c) the software would be supported by a central educational unit, although production and implementation would be undertaken in faculties and departments by academics.

2.3.2 Goal 2: Understanding of the development processes and experience

The individual, cultural attitudes, changing environment and reflection

The second goal reflects my conscious decision to acknowledge the broader factors impacting on practical CFL development decisions, even if they may be beyond my control. These issues concern the individual perspectives, culture and changing workplace environment raised in the formative questions. This is an ‘Interpretive goal’ aiming to establish relationships between such observed phenomena. The descriptions and explanations emerging are intended to inform discussion and to be extended in other studies.

The second goal of the research is then to acknowledge the complex institutional social setting in order to:
(a) expose the rich detail of the technical and social phenomena associated with the process and experience of CFL development; and
(b) describe and relate the emerging factors as a basis for discussion and comparison with other situations.

2.3.3 Goal 3: An organisational model for developing and implementing CFL systems

Strategies and impact

Goal 3 is best described as a ‘Development goal’ seeking to synthesise from the whole project experience an organisational model to guide further CFL systems development. This goal is concerned with issues of organisational strategies and impact raised by the formative questions. It seeks to build from my initial conceptual model for CFL development and the experience of collaborative work with teachers in this study, to usefully portray the processes, stakeholders and effects, based on empirical evidence.

The third goal of the study, therefore is to build a practical organisational model to:

(a) support future development of generic CFL systems;
(b) support collaboration between teacher and developer in the production and implementation of CFL systems; and
(c) facilitate innovation in education through the use of generic CFL systems.

2.4 Scope, significance and limitations of the study

The developmental research was undertaken as an aspect of my regular work in the Multimedia Education Unit at the University of Melbourne between 1996 and 2000. In the course of the study, I was involved to varying degrees in about 30 curriculum projects, in disciplines that included Genetics, Architecture, Veterinary Science, Chemistry, Economics, Education, Engineering, English, History, Music, Optometry and Physiology. While the curriculum design and learning outcomes are fundamental concerns of individual curriculum projects, this research focuses primarily on the generic online learning system behind them, and my experience of the development. Although software engineering comprised a major aspect of the development, I have treated the technical aspects of the inquiry only indirectly.

The purpose of the research is to seek understanding of an authentic CFL development situation and an explanation of what has occurred, rather than attempting to prove any particular theory, although different theories and paradigms are one aspect of the situation. Given the highly contextualised nature of the inquiry, the findings cannot be assumed to generalise to other contexts; however, the comprehensive descriptions of workplace experience and relationships emerging will provide a unique basis for debate and guidance to others that can be complemented by further studies.

The study represents a personal journey for me, but was undertaken in conjunction with others, as evidenced by the analysis, combined publications and other documentation. My ability to fully represent events and others’
perspectives must be recognised as necessarily restricted. Data that might impact adversely on others have been omitted or rendered to portray only the essence of particular situations. This maintenance of privacy and acknowledgment of due contributions are important tenets of the research. The nature of the development, availability of data and the interpretive analysis approach adopted means that my perspective as central developer is fundamentally embedded in the findings. For example, organisational processes have been analysed only through my direct experiences of them. The verification criteria for the research design are discussed in Section 7.7.

2.4.1 Importance of this research

The study addresses calls for long term and intensive development research studies to improve, not prove, the application of technologies to learning (Reeves, 1999, p. 18). This is a unique and triangulated longitudinal study of CFL development in two significant projects, spanning a period of nine years and profound change in higher education and technologies. The generic CFL system developed embodies the multiple educational philosophies and learning requirements of innovative teachers exploring new opportunities for CFL within a wide range of learning contexts.

The goals of this research directly support the stated directions of Melbourne University and the Multimedia Education Unit (MEU) relating to the use of technology and improvement of learning and teaching. An external report in 1998 identified this research as an important mediating approach through which MEU staff could empower academics to efficiently articulate their knowledge of teaching methods (J. Taylor, 1998). It recommended the continuation of such research as “continued demand for the use of internet-based technology in teaching will overwhelm unless [technology mediation] systems of this type can be put in place” (J. Taylor, 1998, p. 33).

The report also recommended that the University develop its understanding of the process of change by reflecting on the histories of project experiences in order to learn from them (J. Taylor, 1998, p. 3). In a working culture focused on ordered management processes and successful outcomes, there is little acknowledgment of unanticipated events and failures associated with any genuine discovery process. This point needs to be acknowledged both by management and by participants themselves, for example, when considering criteria for academic performance.

2.4.2 Anticipated benefits of the research

The most visible outcome of the research will be a generic online learning system embodying the requirements of teachers across a variety of discipline projects. This will enable teachers to construct innovative environments for their students and support them in their role as teachers. The organisational development model will clarify how a culture of collaboration between teachers and developers can further the understanding and implementation of CFL in the University. Taken together, the software and collaboration models will provide a vehicle for re-defining the roles and responsibilities of faculty, department and central support staff as a connected community. For example, the net benefits to the University are likely to be greater if central software design effort is focused on effective generic software tools, rather than individual multimedia course materials.
The study will contribute to community knowledge in various forms, such as educational and organisational models, research methodology and a unique representation of the real-world experience of innovative CFL development. This will be of potential use within professional staff development, online course design and strategic planning within tertiary settings.

Less obviously, the generic online learning system will provide others, specifically teachers, with the ability to articulate their own conceptions of learning and teaching. Knowledge generation from the outcomes of this research will thus continue after the study is concluded.

2.5 Structure and overview of the thesis

The structure of the thesis is outlined below and summarised in Figure 2.2 (p. 22).

Chapter 1 outlined the higher education background and institutional and workplace environment at the University of Melbourne. National and institutional strategies have strongly supported the uptake of CFL, in turn influencing my own role and position within a central educational support unit. My concerns with the broader issues behind CFL development were expressed as a series of ‘formative’ questions, which defined the scope of the study.

In Chapter 2, a research mission was developed from the institutional requirements. Three principal ‘use-inspired’ goals were identified from the formative questions. These focus on software production, understanding of the workplace experience and an organisational model for action.

Chapter 3 defines a field of inquiry for ‘CFL Systems Development’. This encompasses disciplines representing different stakeholders and professional approaches that could possibly guide this study. A framework focused on learning, educational development is developed as a basis from which to review the literature.

Chapters 4, 5 and 6 provide a multi-perspective overview of the literature. Chapter 4 examines the process of learning taking a constructivist perspective. Several theories of learning relevant to higher education are examined and summarised as a pragmatic framework of learning requirements that will inform later chapters. In Chapter 5, a number of paradigms for instructional development are examined. Traditional approaches are related to more recent ones that attempt to deal with the uncertainty and complexity of the learning and workplace situation. The requirements identified for academic learning and a relational model of students and teachers are used to extend the pragmatic framework to inform the design of CFL environments. Chapter 6 examines various perspectives on the organisation: the changing culture of universities, the notion of the learning organisation and the process of innovation and diffusion. The relational model is extended to students, teachers and support staff/developers.

Chapter 7 outlines a rationale for the research methodology. A fundamental constructivist philosophy underpins the adoption of an eclectic mixed methods inquiry paradigm, which acknowledges the assumptions of an authentic setting and multiple goals, disciplines and perspectives. Different models of research are defined for the three goals and the research design is verified against criteria for a naturalistic inquiry.
Chapter 8 details the data and research methods used for the three goals: action research, grounded theory and mixed methods.

Chapters 9 and 10 describe the production outcome of the first goal, the Online Courseware Component Architecture (OCCA) software. Chapter 9 analyses the evolution, functional structure, key technical achievements and capacities of OCCA to support the requirements of learning and teaching. Chapter 10 reports on two specific curriculum applications of OCCA and on the educational significance of other projects across the University.

Chapters 11 and 12 discuss the interpretivist analysis for the second research goal. Chapter 11 provides a narrative history from my perspective as developer within the two case studies. Alternative perspectives on the CFL development are revealed from reviews of the narrative by different stakeholders. A grounded analysis of the data is undertaken in Chapter 12 leading to a descriptive model of CFL innovation from the developer’s perspective.

Chapter 13 outlines the organisational focus associated with Goal 3, which draws from the findings of the previous chapters. The developer-centred model of CFL innovation is re-interpreted from the perspective of those outside the process, to provide a practical model of ‘Collaborative Developmental Research’. An exemplar of the collaborative research occurring within one particular curriculum project in described.

Finally, in Chapter 14 the goal outcomes are discussed against a series of topical themes and limitations of the study and areas for future research are outlined. The contribution of the thesis is then considered against the relational model of organisational roles.
2.6 **Terminology**

Unfortunately acronyms abound in the area of educational technology, although I have attempted to minimise these and use footnotes to clarify less common terms. The following terminology is used on a consistent basis throughout the thesis. A more comprehensive index of terminology is provided in Appendix 1 (p. 263).
2.7 Summary

I have shown how this research draws its mission, to transform learning and teaching through the development of a generic online learning system, from policies of the University and Multimedia Education Unit, opportunities afforded by new technologies and my own position responsibilities. The broad purpose of the study reflecting this mission represents a ‘development goal’; to apply creative approaches meeting specific teaching production requirements, while seeking a generalised cross-faculty solution and understanding of the CFL development process itself.

Formative questions about the problematic nature of CFL development raised at the commencement of the study assisted in focusing the research purpose. Dimensions of the authentic workplace setting emerging from these questions provided the foundations for three goals aligned with the research mission.

Goal 1 is to produce a generic online software system in conjunction with academic users. This is an ‘action’ goal that capitalises on new Web-based technologies in 1996 and the opportunity to adapt the successful TutorialTools software previously developed within a single discipline setting.

Goal 2 represents an ‘interpretivist’ goal to describe and interpret the CFL development process by analysing the real life workplace experience. This goal seeks to make sense of the complex technical and social phenomena in a particular setting, which while not generalisable to other contexts, can inform discussion and further research.
Goal 3 is a broader ‘developmental’ goal building on the other findings, to create a practical organisational model for further CFL systems development within the institution. The developer/teacher collaboration is assumed central to the innovation process within the institution.

These three goals provide a triangulated framework for the study, reflected in different paradigms in the literature, methodologies, research methods and outcomes. The strength of the research draws on this multi-perspective focus on production, understanding and the organisation, in a longitudinal study based on the experience of two development case studies spanning nine years. Multiple perspectives of teaching staff from many faculty areas are also reflected in the generic design of the software.

The research addresses calls for long term and intensive research studies to improve, not prove, the application of technologies to learning and for institutions to reflect on the history of project experiences to facilitate the process of organisational learning. Greater understanding of the organisational process of CFL development is likely to inform the design and implementation of more effective CFL resources in the institution.

In the next chapter, the scope of the field of inquiry relevant to this investigation is defined, which provides a framework for a review of the research literature in Chapters 4, 5 and 6.
CHAPTER 3. CFL Systems Development: a review of the field of inquiry

3.1 Introduction

With the purpose and goals of the research established in the previous chapter, existing literature can be examined for guidance and to locate the study within existing research. This is a somewhat problematic exercise, however, given the multi-disciplinary nature of the inquiry. The study, for example, could draw from the practices in diverse professional fields including evaluation, information systems, instructional design, organisational management, programming, research and teaching. Choice of particular methods will depend on the background experience and skills of individuals and the resources available. For example, software development could be undertaken with either a ‘systems’ or ‘multimedia’ focus, using quite different tools, programming languages and design approaches. In other words, there is no single ‘field of inquiry’ that would specify the most appropriate approach to this study.

In this chapter, I define ‘CFL Systems Development’ as a specialised field of inquiry that encompasses the specific purposes and contextual setting of the study. This provides the basis of a framework for the multi-perspective examination of the literature undertaken in Chapters 4, 5 and 6.

3.2 Defining a field of inquiry

A ‘field of inquiry’ is defined by the context, stakeholders and processes pertaining to a specific investigation. The scope of a particular field is characterised by some broad purpose and background setting and is underpinned by discourse in the literature representing the methodologies, communities and accepted approaches (Figure 3.2). Any particular field of social inquiry will not be entirely self-contained but will interact and overlap with others. In the figure, for example, a wider political context will influence the perceptions and actions of
individuals at every level, who may in turn influence future political outcomes; however, some pragmatic representation is necessary as a starting point for discussion.

![Diagram of the scope of a field of inquiry]

**Figure 3.2** The scope of a field of inquiry

*Paradigms* in this model represent clearly delineated and well-established modes of inquiry informing the actions and discussions of participants within particular fields (Dills & Romiszowski, 1997b, p. ix). They represent a shared value system that binds and advances the interests of a common community, although the explicit or implicit rules and regulations behind them serve to filter outside information and change the way people see things and accommodate new ideas or anomalies (Davies, 1997, p. 35).

The extent, focus and theoretical underpinning of paradigms are under endless debate, reflecting diverse and changing social attitudes, for example, between constructivist and traditional instructional design approaches (Duffy & Jonassen, 1992b). It is even suggested that approaches to inquiry in the social sciences are ‘pre-paradigmatic’ (Kuhn in Reeves, 1997, p. 164). That is, consensus has not been reached on the fundamental assumptions and methodologies appropriate to the complexities of human behaviour. The boundaries of the field of educational development are still undefined, let alone the ways to think within them (Dills & Romiszowski, 1997a, p. 18). Where certain paradigms do indeed dominate, they can be “counter-productive to the creativity that underlies authentic inquiry” (Bohm & Peat in Reeves, 1997, p. 164). In the field of educational development, there appears to be broad agreement that the accepted theories, paradigms, roles and activities need to be redefined and broadened to reflect the changing needs of education.

Aspects of the field of inquiry are visible through the evolving discourse in books, journal articles, online discussion lists and other sources. This serves to shape the common language and methodologies broadly accepted within each community, although the notion of distinct and well-ordered communities of stakeholders is unrealistic. Meta-level or *conceptual overviews* in the literature can facilitate debate and provide holistic guidance for an inquiry within a general area. Dills and Romiszowski’s book *Instructional Development Paradigms*, for example, overviews the various schools of thought on instructional development (Dills &
Romoszowski, 1997b). Such a conceptual overview enables participants to step outside their immediate professional knowledge area, to perhaps rethink their fundamental approach.

Alternative interpretations or emphases on a field may be provided by different conceptual overviews. In higher education, for example, Laurillard’s book *Rethinking University Teaching* draws on a body of empirical research on student learning, to structure a ‘Conversational Framework’ to support teaching (Laurillard, 2002). Another interpretation of similar research studies is given by Prosser in the book *Understanding Learning and Teaching*, which builds key principles for good teaching practice (Prosser & Trigwell, 1999). Neither interpretation is the ‘correct’ one, but both offer insights into CFL Systems Development in higher education. Unfortunately in the real world of higher education, few teachers or developers have time to fully explore all possible interpretations in order to make practical decisions (Laurillard, 2002, p. 186).

More focused conceptual overviews of specific fields of inquiry can therefore facilitate the discussion, language and approaches to guide practical action by participants. The following section outlines the scope and characteristic of the field of inquiry associated with this study, to provide the foundations for a review of the literature in the following chapters.

### 3.3 The field of ‘CFL Systems Development’: a definition

By definition, this study is located within a particular field of inquiry I will call ‘CFL Systems Development’. The scope of this field is shaped by its unique institutional setting (Chapter 1), the goals of the study (Chapter 2), relevant research literature and the approaches of teachers, developers, programmers and management staff connected the inquiry. Figure 3.3 outlines the field in relation to the structure of the study, building on the field of inquiry model from Section 3.2. While the CFL Systems Development field is defined for the purpose of this study, its general focus would be relevant to CFL development in other higher education settings.

![Figure 3.3](image-url)

*Figure 3.3 The scope of the field of inquiry for this study: ‘CFL Systems Development’*
Various paradigms potentially relevant to this field of inquiry are reviewed in Chapters 4, 5 and 6. Together these constitute a conceptual overview of the CFL Systems Development field, drawing together a selection of possible approaches aligned with the purpose and goals of the study. A framework for the overview is outlined in Section 3.5 and is structured around the three perspectives of learning, educational design and development, and the organisation.

Methodology and methods applied within the study will be treated in Chapters 7 and 8 respectively.

### 3.4 Aligning the field of inquiry with the research purpose

The task of reviewing literature relevant to CFL Systems Development is made difficult by the multi-disciplinary and authentic nature of the inquiry. While the first goal reflects general CFL production requirements, my concerns about pace of change, pressures on staff and effectiveness of approaches expanded the scope of the study to examine the real workplace experience in Goal 2 and to generalise this into a practical institutional strategy in Goal 3. These goals are of course inter-dependent and, as indicated in Chapter 2, their combined purpose represents a ‘development goal’. That is, the study aims to solve a particular real-life problem, while simultaneously informing wider practice and understanding in other contexts.

The appropriate research methodology is discussed in Section 7.3; however, it is appropriate to bring forward the underlying philosophy of the investigation in order to inform the literature review. An eclectic-mixed methods-pragmatic approach is chosen as most appropriate for the complex social setting and practical nature of the inquiry. The key assumptions for the inquiry are:

- **an openness** to revisit fundamental assumptions and to seek alternative approaches;
- engagement with ‘authentic’ problems involving complex settings with meaningful problems;
- acknowledgment of the multiple perspectives of stakeholders;
- acknowledgment of the multiple disciplines shaping the language, assumptions and methods of different communities; and
- adoption of a **pragmatic approach** to real problems within the limits of the inquiry resources.

These assumptions should also serve to inform the literature review. Thus it will need to be an open examination of community theories and practices focused on improving practical understanding of the problem at hand. It should portray multiple perspectives on real-life situations and, importantly, must be made accessible to stakeholders, for example, by using plain English descriptions and avoiding complex conceptual models.

In summary, key criteria for the selection of literature relevant to the field of CFL Systems Development are that it:

- represents a judicious selection of views to improve understanding of the problem at hand;
- seeks to address multiple perspectives of stakeholders; and
- is accessible to stakeholders.
Many well-developed professional approaches are potentially applicable to the study. Table 3.1 maps some of these, indicating their relevance to particular goals (Section 2.3 and suggesting conceptual overviews in the literature.

<table>
<thead>
<tr>
<th>Professional paradigm</th>
<th>Description</th>
<th>Goals</th>
<th>Conceptual overviews</th>
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<tr>
<td>Diffusion of innovation</td>
<td>A process of introducing change in a social system. Main elements are the innovation, channels of communication, timing and the social system (Rogers, 1995) and the concepts of innovators, early adopters, change agents, success and failure of innovations, institutionalisation, diffusion models, etc.</td>
<td>1(b)</td>
<td>(Ely, 1997; Hannan &amp; Silver, 2000; Holloway, 1996; Rogers, 1995)</td>
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<tr>
<td>Educational evaluation</td>
<td>Originally focussed on measurement of the achievement of goals, describing or judging the merit or worth of an initiative (Alexander &amp; Hedberg, 1994 pp. 234-5). This might be concerned with student learning or a technological innovation for example. Other interpretations stress the social aspect for which stakeholders, including the evaluator, ‘make sense’ of the situation they are in and shape the negotiation of concerns and issues (Guba &amp; Lincoln, 1989, p. 13).</td>
<td>1.2</td>
<td>(Alexander &amp; Hedberg, 1994; Bain, 1999; Guba &amp; Lincoln, 1989; Keeves, 1997; Phillips, Bain, McNaught, Rice &amp; Tripp, 2000; Reeves, 1997)</td>
</tr>
<tr>
<td>Information systems research</td>
<td>Study of improvement in the effectiveness of information systems design, implementation and use in organisations. This is a new and highly applied field that tends to borrow research frameworks and techniques. Research ranges from purely technical perspectives of systems design to social perspectives on the structural and social consequences of information systems at the individual, organisational and societal levels (Garcia &amp; Quek, 1997, p. 448).</td>
<td>1(a)</td>
<td>(Lau, 1997; Lee, Liebenau &amp; DeGross, 1997)</td>
</tr>
<tr>
<td>Instructional design and development</td>
<td>A systematic approach applied to the development of teaching events, activities or materials and using a range of technologies (Dills &amp; Romoszowski, 1997a, p. 6). Generally characterised by defined professional activities to determine needs, analyse goals, learners and settings, design plans and materials and evaluate outcomes.</td>
<td>1(b)</td>
<td>(Dills &amp; Romoszowski, 1997b; Jonassen, 1996)</td>
</tr>
<tr>
<td>Organisational learning</td>
<td>A broad area of study looking at how organisations respond to changing environments by generating and selectively adopting organisational routines. Serves the practical orientation of consultants and practitioners as well as theorists (Argyris, 1999, pp. 1-8).</td>
<td>1(b)</td>
<td>(Argyris &amp; Schon, 1996; Clark, 1998; Senge, 1992)</td>
</tr>
<tr>
<td>Reflective practice</td>
<td>A reaction against the notion of technical rationality in the professional practice of design, management, teaching, engineering etc. Reflection-in-practice and tacit understanding are central to the ‘art’ by which practitioners handle situations of uncertainty, instability, uniqueness and value conflict (Argyris, 1999, p. 50).</td>
<td>2(a)</td>
<td>(Argyris, 1999; Schön, 1987, 1996)</td>
</tr>
<tr>
<td>Software engineering</td>
<td>While originally approached as a linear sequence of steps, many models of software design now emphasise some form of iterative or evolutionary approach.</td>
<td>1(a)</td>
<td>(Pressman, 1997)</td>
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From the range of possible options suggested in Table 3.1, I could approach the study from a variety of directions, coming up with quite different strategies, language and methods. For example, a software engineering approach, with its well-developed methods for dealing with complex software developments and commercial accountability, might suggest that teachers are viewed as clients, with needs to be assessed and specifications to be drawn up. It is likely, however, that the language and methods of the software development community will
not fully align with the practices and assumptions of the academic community, who may feel disempowered by the process.

One approach might be to mix and match approaches for specific aspects of the inquiry. Incorporating strongly focused models and terminologies from different professional areas, however, adds complexity with conflicting interpretations and terminologies that might compromise the openness sought in this inquiry.

3.5 A conceptual overview of CFL Systems Development

The conceptual overview of the field of CFL Systems development needs to align with the purposes and context of the study, according to the literature selection criteria of the previous section. To structure the overview, I have chosen three particular vantage points or perspectives that are particularly relevant to aspects of the study. These vantage points examine paradigms in relation to the learning process, educational design and development and the organisation (Figure 3.4).

![Figure 3.4 Structure of the conceptual overview of the CFL Systems Development](image)

A vantage point on learning is taken in Chapter 4, surveying views on the nature and requirements of learning in the academic context. Influenced by such a view, various paradigms for CFL design and production are explored in Chapter 5. Finally, Chapter 6 looks at such component processes from an organisational perspective, in order that an institution can support and learn from these experiences.

Although these three perspectives relate closely to the goals of the study (production, workplace understanding and the organisation), there is not a one-to-one relationship between them. For example, consideration of CFL production must embody underlying conceptions of the learning process, but will also be subject to the influences of the organisational setting. Thus, a brilliant learning design will ultimately fail if not nurtured by the institutional strategy. Conversely, a learning design must account for institutional realities if it is to succeed.

While it is tempting to categorise students, teachers, developers, managers or support staff with particular perspectives on the situation, the rapidly changing education environment means that roles and stakeholder cultures must also be responsive to change. For example, teachers must see themselves as learners as they grapple with new technologies, changing roles and understanding the requirements of their students. Participants are also entering this field with widely different backgrounds and approaches.
The need to approach a CFL development with an open mind can be illustrated with an example. At a seminar at the University of Melbourne in the mid 1990s, Diana Laurillard recounted the story of how a group of students completing a computer-facilitated subject demonstrated significant improvement in learning. While the teachers were pleased, it surprised her as she knew the program was not well designed. On speaking with the students, it became apparent that they also thought the program was poor. So poor that they decided the only way to pass was to collaborate. By working as a team and pooling their understandings, they were able to develop strategies to circumvent the poor resources and actually end up with a profitable learning experience.

The story touches on many of the formative questions raised in Section 1.7. There are multiple failures in CFL design, evaluation, implementation and institutional quality control measures. It demonstrates the different perspectives of the stakeholders uncovered by research activity. On the other hand, the idea of students taking responsibility for their own learning, working collaboratively and applying their skills to ‘ill-structured problems’ may be seen as desirable experience. Regardless, the effort no doubt spent on the CFL development seems to been misaligned with student needs.

The following three chapters will examine the literature relevant to CFL Systems Development using this conceptual overview structure.

3.6 Summary
A ‘field of inquiry’ defines the scope of an investigation in terms of some broad purpose and background context. Different community paradigms define the accepted theories and value systems shaping the field, which will be constantly evolving in response to changing social attitudes, technologies and understandings. Conceptual overviews in the literature facilitate discussion and are important for cross-disciplinary flow of ideas.

The authentic nature of this study means that no existing field of inquiry will fully inform the approach, values and methods to be adopted. I therefore defined a specific field of ‘CFL Systems Development’ encompassing the purposes and context of this study, to guide the review of the literature in the following three chapters. This review is also underpinned by the philosophical approach of the study that emphasises openness, authentic problems, multiple stakeholder perspectives, multiple disciplines and pragmatism. Bearing in mind that many discipline areas that could inform different aspects of this study, the literature will be selected to:

• represent a judicious selection of views to illuminate the problem at hand;
• address the multiple perspectives of stakeholders; and
• be accessible to stakeholders.

To draw together a pragmatic inquiry framework of possible approaches, I have created a structure for the literature review in the Chapters 4, 5 and 6 from the three vantage points of:

• learning – what is it and what are the requirements of learning at university level?
• educational design and development – how can learning environments be designed and implemented?
• the organisation – how are component processes integrated and how does the institution itself learn?
The multi-perspective overview of the field of CFL Systems Development undertaken in the following chapters will guide the research design and position the study in relation to other research.
CHAPTER 4. Perspectives on learning

Figure 4.1 The field of CFL Systems Development taking a perspective on learning

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4.1 Introduction

This is the first of three chapters reviewing the research literature for paradigms and approaches aligned with the goals of the study. Together these provide a multi-perspective overview of the field of ‘CFL Systems Development’ to guide the study and relate it to current discipline research and professional approaches (Section 3.3). This chapter examines a range of perspectives on the process of academic learning that acknowledge real world contexts and multiple perspectives of stakeholders. The philosophical position on learning developed here lays the foundation for an examination of paradigms of educational design and development in Chapter 5 and the organisation in Chapter 6 (Figure 4.1).

The review builds from the constructivist worldview that learning and teaching are inherently social activities, contextually dependent and grounded in the individual experience. These assumptions underpin the philosophical approach of this study, as well as the research into student learning that has informed the two principal learning models examined in this chapter. The Conversational Framework and 3P model of learning and teaching provide complementary perspectives drawn from empirical evidence of the nature and the requirements of academic learning. These are summarised in a practical overview of key points informing teaching and CFL design.
4.2 Philosophical beliefs about knowledge and learning

An individual’s fundamental worldview influences how they think about learning and consequently, how they might approach teaching or the design of CFL environments. Philosophical debate within education is often portrayed in terms of two opposing worldviews and associated approaches to inquiry. These are loosely characterised as:

- objectivist – often referred to as positivist, realist, scientific or traditional; and
- constructivist – also referred to as interpretivist, naturalist, hermeneutic or alternative.

I have taken the position in this study that a constructivist worldview is particularly appropriate for approaching the real-life complexity and multiple perspectives implicit in the goals of this study (Section 7.2). The objectivist or traditional perspective, however, remains influential on attitudes and processes found within the university setting.

*Learning from a traditional/objectivist worldview* is about achieving complete and ‘correct’ understanding in the learner (Duffy & Jonassen, 1992a, pp. 2-3). While individuals are likely to have different understandings, these are seen as incomplete or biased, originating from their differing prior experiences. The aim of teaching or ‘instruction’ is to correct these partial or ill-formed views to more closely approach the ‘correct’ understanding. Knowledge to be taught is thus considered separate from the process of instruction. The implications of this view are that the objectives of instruction can be planned according to some absolute classification of knowledge and a student’s performance tested against independent criteria for ‘mastery’ of learning.

*Learning from constructivist worldview* is about individuals creating unique interpretations of the world based on their past experiences and interactions with it (Cunningham, 1992, p. 36). A constructivist view sees learning as conceptual change in the individual, rather than a process of knowledge acquisition (Biggs, 1999, p. 13). Learning represents a change in meaning constructed by the individual from their prior experience and through collaborative interaction with others. One implication of this view is that meaning is constructed within the specific context of the learning situation; both students and teachers are therefore implicated in the learning process (Tam, 2000, p. 51). The teacher is not seen as the knowledge expert, but as someone who can set up the collaborative situation and provide opportunities for students to construct new meanings based on their prior knowledge. If knowledge is therefore dependent on the environment in which it was acquired, there are implications for the design of learning if the learner is to apply such knowledge in other contexts. That is, understanding gained from a given learning encounter may be fundamentally different in character to knowledge that can be generalised to other contexts.

It is from this constructivist worldview that I have approached both the design requirements of the generic CFL system and the workplace process of development.

4.3 Learning research approaches

While there has been a great deal of research into learning and teaching over the past century, this has had relatively little impact on teaching, largely because much of the focus has been on developing a ‘grand theory’ of learning (Biggs, 1999, p. 11). The recurrent finding of research appears to suggest that we can never assume that
the impact of teaching on student learning is what we expect it to be (Ramsden, 1992, p. 6). The alignment of research purpose and methodology are therefore critical if education practice is to be improved. The nature of the research coming from the alternative worldviews in Section 4.2 is considered here.

Knowledge obtained in *traditional/scientific studies* is expected to be ‘reliable’ and ‘valid’, that is, experiments must be repeatable and findings applicable in a range of situations (see also Section 7.7). Educational researchers following this approach conduct various types of studies into learning to establish relationships between phenomena by attempting to reduce the effect of external variables and running controlled experiments. Significantly, learners themselves are “not considered to be good sources of knowledge about learning” as their reports “often vary from time to time and from learner to learner” (Gagné & Driscoll, 1988, p. 4). This form of scientific research underlies the traditional instructional development movement, which will be examined in Section 5.2.

An alternative interpretivist research approach is reflected in *phenomenographic studies* of tertiary learning originating in the 1970s with work of Entwistle in the United Kingdom; Säljö, Marton, Dahlgren and Svensson in Sweden; and Biggs in Australia (summarised in Prosser & Trigwell, 1999, p. 88). Marton and Säljö’s seminal study of students’ approaches to learning (Marton & Säljö, 1976) is said to be the most cited in the educational research literature (Biggs, 1999, p. 31). Phenomenographic studies focus on real learning situations, emphasising *descriptions* of phenomena emerging from retrospective accounts, to reveal student conceptions and misconceptions of the topic and the learning context (Marton, 1981, 1994). Such studies focus on individual variations in conceptions and the different approaches of students and teachers, rather than on ‘explanations’ of learning or ‘categorisation’ of students. Of particular significance has been the identification of ‘deep’ and ‘surface’ approaches to learning observed in studies across many subject areas and learning contexts.

This line of inquiry suggests that students’ approaches are profoundly influenced by the learning environment and that they react to demands of teaching and assessment in ways that are difficult to predict. With increased intake to university and greater modularity of courses, it is difficult to make assumptions about students’ prerequisite knowledge or attitudes to learning (Laurillard, 2002, p. 25). For example, examination results, as the most convenient approach to investigation, say nothing about a student’s approach to learning and little of the detail of prerequisite knowledge. Any investigation of what students bring with them to learning should be set in the context of the real learning situation. For example, broad scale studies of student characteristics, such as motivation, learning style or intellectual development, will offer little indication of variability across particular learning situations.

Given the difficulty of reaching practical understanding of the individual nature of student learning, it is useful to consider the investigative role of the teacher, who must elicit what they need to know about their students in order to teach, within the context of the learning situation. One implication is that CFL environments should include mechanisms to facilitate teachers’ understandings about individual students and their preconceptions. This requires more than just observing the behaviour of students, for example, their performance in tests. It is the students’ conceptions of the learning situation, their approaches to learning and their learning outcomes that should inform both teaching and the design of CFL environments. Learning and teaching are fundamentally related by the common context in which students and teachers are engaged (Prosser & Trigwell, 1999, p. 11). At
a fundamental level, good teaching requires an understanding of the variation in the way in which students experience the planned learning situation. This places the teacher into a position of responsibility when it comes to applying technology to teaching and designing CFL environments.

4.4 The nature of learning in higher education

The nature of learning can be explored by considering the expectations of different stakeholders. For example, the perceptions of learning outcomes by adult learners have been observed to range from:

- a qualitative increase of knowledge, acquiring information;
- memorising, storing information that can be reproduced;
- acquiring facts, skills and methods that can be retained and used as necessary;
- making sense or abstracting meaning, relating parts of the subject matter to each other and to the real world; to
- interpreting and understanding reality in a different way, comprehending the world by reinterpreting knowledge (Säljö 1979 in Ramsden, 1992, p. 26).

The first three perceptions suggest an external quality to learning; it is something that just happens or is provided by the teacher. The last two categories, on the other hand, emphasise its internal or personal aspects, with quality learning requiring a degree of conceptual interpretation actively constructed by the learner.

Other studies reveal the learning objectives teachers have for their students, who will expect them to:

- analyse ideas or issues critically;
- develop intellectual/thinking skills;
- comprehend principles or generalisations;
- adopt a lifelong learning approach;
- have the capacity to respond flexibly to changing circumstances; and
- integrate theory and practice by generalising from theoretical to new situations (Ramsden, 1992, p. 20).

These are worthy expectations although it is arguable about whether the goals are currently being met by conventional instruction and course administration (Ramsden, 1992, p. 20). The learning objectives can be broadly grouped into three levels (Ramsden, 1992, p. 18). At the first level are general abilities and personal qualities, such as thinking skills and the ability to think critically. At the second are more content-related changes linked to disciplines and professions, such as understanding the principles and practices of a discipline area. At the third level are specific skills and factual knowledge.

The expectation of university education is that students will be able to connect knowledge across different levels. That is, learning of an ‘academic’ nature involves more than just acquiring either factual or high level knowledge. It requires interplay between such knowledge, involving some form of ‘theoretical’ discourse and practical application, by implication within different settings (Laurillard, 2002, p. 13). If we accept that students need to relate their knowledge to practical applications in different contexts, then it must somehow be abstracted from its physical and social context. This is somewhat at odds with the notion of ‘situated learning’, which suggests that knowledge has a contextualised character and cannot be separated from the setting in which is used (Brown, Collins & Duguid, 1989, p. 32). While learning activities within realistic situations can provide useful
concrete examples for certain well-chosen situations, these may not be sufficient for the student to fully develop the abstractions necessary to apply the knowledge in other contexts (Laurillard, 2002, pp. 14-5).

There is a clear distinction between the situated/experiential and conceptual components of learning at an academic level (Table 4.1). Everyday knowledge is set within a natural environment, involves direct experience and is probably tacit in nature. Conceptual knowledge, on the other hand, is about second order, abstract representations of the world and is necessarily mediated by the teacher or some outside agent. That is, communication is an inherent aspect of academic knowledge and development of ideas about the world. Moreover, it cannot be assumed that these different forms of learning can be treated the same way. They represent fundamentally different understandings of the world. Conceptions acquired from direct involvement with a natural phenomenon and its symbolic representation gained via someone else’s articulated interpretation, represent significantly different forms of knowledge. They are acquired under different conditions of learning.

Table 4.1 Constituent components of academic learning – experiential and conceptual knowledge

<table>
<thead>
<tr>
<th></th>
<th>Everyday ‘experiential’ knowledge</th>
<th>Academic ‘conceptual’ knowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Context</strong></td>
<td>First-order experience of the world, a ‘natural’ environment.</td>
<td>Second-order descriptions of the world, a mediated academic environment.</td>
</tr>
<tr>
<td><strong>Knowledge</strong></td>
<td>Tacit, common sense, experiential perceptions of everyday life.</td>
<td>Articulated principles, symbolic representations or descriptions of the world.</td>
</tr>
<tr>
<td><strong>Learning process</strong></td>
<td>Direct experience of the world, situated cognition.</td>
<td>Reflection on experience of the world, mediated, acquiring understanding of others’ insights.</td>
</tr>
<tr>
<td><strong>Teaching role</strong></td>
<td>Creating of natural environments.</td>
<td>Creating environments to change the way students are able to think about the world.</td>
</tr>
</tbody>
</table>

(after Laurillard, 1993)

4.5 Models of learning

The importance of the learning context has emerged from studies of student learning as discussed in the previous section. Two interpretations of the learning at university level that are derived from empirical evidence are examined here.

4.5.1 The Conversational Framework of learning

Laurillard’s widely cited ‘Conversational Framework’ depicts the necessary student and teacher activities for academic learning (Laurillard, 1993, p. 104; 2002, p. 86). This derives from the empirical evidence of phenomenographic studies (Laurillard, 2002, p. 69), building from the model of academic knowledge discussed in Section 4.4. The model provides a core structure for the learning process in which the student alternately interacts with a learning environment created by the teacher and discusses theoretical descriptions of knowledge with the teacher (Figure 4.2). Thus, the development of experiential and conceptual knowledge comes about through a process of articulation and adaptation to feedback, arising from interaction with the experiential environment and discussion at the level of theory. It is important to recognise that the teacher is also engaged in learning: eliciting student conceptions and misconceptions and consequently adapting the learning environment.
The essential characteristics of academic learning represented by the Conversational Framework are that:

1. The teacher and student operate iteratively and interactively on two levels:
   - discussion with the teacher at a conceptual level; and
   - practice within an environment constructed by the teacher.

2. Learning is an iterative process involving:
   - reflection on learner’s performance by teacher and learner; and
   - adaptation of the world by teacher and action by learner.

The framework can be extended to address the process of abstraction required for academic knowledge to be applied to other contexts (Laurillard, 1999, p. 115). Thus, for the student’s learning to go beyond a specific learning encounter, a parallel ‘conversation’ also must occur at an internal level (see Figure 4.3, p. 39). In this conversation, the specific experience and its emerging conceptual descriptions are related to the student’s internalised experiences and conceptual descriptions from previous encounters. A conversation takes place between the ‘externally-situated’ individual and the ‘internally-persistent’ individual who is ‘common to all the experienced situations’. Therefore, for learning within a specific situation to be generalised, the student must engage in a separate internal conversation involving:

- reflection at a meta-level on the specific experience and teacher’s articulation of theory; and
- adaptation of generalised conceptual representations.

If any aspect of this extended conversation is absent, full learning of the type required for academic knowledge will not occur. For example, where the only interactions are between the student and teacher-constructed environment (left and centre boxes at bottom of Figure 4.3), learning represents only ‘conditioning’ to the particular environmental conditions (Laurillard, 1999, p. 115). Another common failure occurs when the internal conversation is absent (i.e. the two right hand boxes missing). Although reflection is present, the scope of learning will be restricted to the particular context. The notion of generalising knowledge has parallels to the ‘deep’ approach to learning discussed in the next section.
The Conversational Framework defines the core structure of an academic dialogue; however, as the topic focus shifts, roles change or additional participants come in to the learning situation, additional conversational frameworks can be mapped (Laurillard, 2002, pp. 88-9).

The potential contribution to learning of different educational media or modes of teaching can be analysed by modelling the range of learning interactions they support. Care must be taken with generalised categorisations, however. For example, lectures may not appear to involve student reflection or re-description directly, but these activities may be supported within later personal study or tutorials (Laurillard, 2002, p. 92). Lecturers also can use techniques to encourage effective inter-student communication through active learning techniques (e.g. Biggs, 1999, p. 107; Silverstone, 2001).

Another observation is that the framework does not specifically address the development of learning skills (Draper, 1999). On the surface, the act of ‘reflection’ might suggest the student is considering the process of learning; Laurillard’s emphasis, however, is on conceptual development related to topic goals (Laurillard, 2002, p. 78).

4.5.2 The 3P model of learning and teaching

An alternative model relevant to the higher education focuses on the perceptions and approaches of students and teachers. This work derives from many of the same phenomenographic studies (Section 4.3) underpinning the Conversational Framework, which drew attention to the variation in students’ approaches to learning. In particular, two qualitatively different ways in which students approached a learning task with either a ‘deep’ or ‘surface’ approach have been consistently identified in many studies across a range of tasks, topics, subjects and courses.

Students adopting a ‘deep’ approach to learning aim to understand ideas and to seek meaning by making the task coherent with their own experience. They look for patterns and underlying principles and relate what they understand to the rest of the subject and to other subjects (Trigwell, 1997, p. 3). On the other hand, students
adopting a ‘surface’ approach see the learning task as an external imposition and aim to meet its demands with minimum effort. They focus on essentials and treat parts separately, concentrating on reproduction and memorisation for the purposes of assessment, rather than understanding.

Phenomenographic studies have revealed a critical link between the learning approach students adopt, that is, a deep or surface approach, and a student’s perception of their situation. It is their whole situation that is relevant here, for example, a student working part-time may perceive they have little time to spend on study. Further, the approach taken by the teacher will play a crucial role in influencing the perceptions of students and hence the approach they adopt. The approach taken by a student is in turn, fundamentally related to quality of learning outcomes (Prosser & Trigwell, 1999, p. 15).

The ‘3P’ or ‘presage-process-product’ model of student learning shown in Figure 4.4 was proposed by Biggs in 1978 to represent this relationship (Prosser & Trigwell, 1999, p. 12). This model represents a balanced system of ‘presage’ (student factors and the teaching context), process (learning activity) and product (learning outcomes). The learning outcomes are determined by many factors; however, the contributing aspects cannot be extracted and treated in isolation. It is important to note also that a student cannot be categorised simply by the approach they take, although certain propensities may be indicated. For example a student with little prior knowledge of a topic will tend to adopt a surface approach, but so will another student with a strong understanding, but under severe time pressure (Biggs, 1999, p. 19).

Figure 4.4 Presage-Process-Product (3P) model of student learning (Prosser & Trigwell, 1999, p. 12)

The 3P model offers another instrument that can be applied to the design of learning activities. Student factors (prior knowledge, interest, ability etc.) and teaching context (what is intended to be taught, how it is taught, expertise of the teacher, forms of assessment and general classroom ethos) interact at the process level to determine the student’s immediate learning-related activities, that is, approaches to learning (Biggs, 1999, p. 18).

Good teaching focuses on what students do and will:

- maximise the chances that students will use a deep approach; and
- minimise the chances that they will use a surface approach.
Much traditional practice, for a variety of reasons, has the opposite effect (Biggs, 1999, p. 30).

In summary, the Conversational Framework and the 3P model offer complementary means of thinking about the interactions between student, teacher and CFL environment, to support the type of learning required at an academic level. In the next section I will look at the characteristics of environments that can foster deep learning.

### 4.6 Requirements for academic learning

The two models of the learning introduced in the last section are further examined here in order to identify specific requirements for learning in higher education that might underpin CFL development. The structure of micro-level learning events assisting the conceptual development of students’ knowledge is examined and consideration is then given to the influence of teaching practice on the learning situation.

#### 4.6.1 Learning activities

Although individual accounts of how and what students learn do not in themselves explain the process of learning, they can reveal characteristics of possible approaches and associated outcomes (Laurillard, 2002, p. 42). A breakdown of learning ‘affordances’ is just one possible way of looking at the learning process, but can provide a useful framework to guide teaching and the application of technology. Laurillard has identified five key requirements of academic learning activity.

**Apprehending structure**

Meaning is given to information through its structuring by the student (Laurillard, 2002, pp. 43-8). For example, a student taking a deep approach to the study of a particular text would look for meaning in a holistic manner, taking into account the original structure of the discourse and preserving its intended meaning. A student taking a surface approach might focus on key words or phrases, distorting the original structure and changing the intended meaning. In the case of problem solving, the main focus of some students may be on simply getting the answer, while others are able to develop the facility of mathematical manipulation and appreciate the meaning of the answer they have produced. It is also likely that, despite the best intentions of the student, the nature of the academic discourse may make the task of discerning the broader understanding difficult.

**Interpreting forms of representation**

A key characteristic of academic knowledge is its relational nature, indicated by representations of ideas about the world and expressed in different forms, such as text, image and other symbols (Laurillard, 2002, pp. 48-52). Academic learning requires the student to undertake learning activities to develop their skills in interpreting such linguistic, pictorial and other symbolic descriptions of ideas that lie beyond their natural conceptions of the world. The student must be able to make sense of alternative representations of a concept and to appreciate their purpose.

**Acting on the world (of descriptions)**

Learning by doing is recognised as an important aspect of learning, indicated by university teaching methods, such as laboratory practical classes, field trips, essays, exercise tasks and so on (Laurillard, 2002, pp. 52-5). For academic knowledge, learners must deal with second order descriptions of the world and access can only be...
through representations, such as language, symbols, images and so on. This contrasts with their access to experiential knowledge (Section 4.3). For example, learning about molecules cannot be carried out without recourse to language or other forms of representation. The experience of students undertaking an academic course contains many activities involving direct experience of the world that will support later analysis and reflection on conceptual descriptions. A Humanities student may read books or attend plays, while a Science student may use laboratory equipment. These direct experiences will play a part in the learning of the second-order component of academic knowledge.

**Using feedback**

Appropriate feedback in response to learner action is critical if the action is to be adjusted in the process of learning (Laurillard, 2002, pp. 55-8). It must be accessible and in a form meaningful to the student. Feedback is either ‘intrinsic’, as in the case of direct responses by the world to an action, or ‘extrinsic’, as administered by an external agent and not as a direct consequence of the action. The dialogue between a tutor and student would involve extrinsic feedback from the tutor in response to the actions of the student. Thus academic learning would involve intrinsic feedback to actions in the directly experienced world, as well as extrinsic feedback in response to their descriptions.

**Reflecting on goals-action-feedback**

The learning goals play a key role in bringing together the action, feedback and integration aspects of learning (Laurillard, 2002, pp. 58-61). Through a reflective process, what has been achieved is considered against the original goals, actions taken and subsequent feedback, to inform further cycles of the learning process. Phenomenographic analysis has provided empirical insights into the meta-level activities associated with goal setting, planning and revising. It should be pointed out that, while the teacher may have a clear goal in mind, there is clear evidence that different interpretations may be made by individual students. The actions of students may indicate that their main goals have more to do with completing tasks for the teacher than in developing a deeper understanding of a concept. Academic goals are primarily set by the teacher, but their re-interpretation by the student within their particular learning context may profoundly affect their learning approach, for example, promoting either a surface or deep approach. The teacher needs not only to set a task goal but also to develop the student’s perception of what is required and how to act reflectively.

**4.6.2 Maximising a deep approach to learning**

From the 3P model of Section 4.5.2, it is apparent that teachers designing learning and teaching contexts need to recognise that each student will perceive his or her situation differently. There is an important distinction between the learning context, which may be the same for all students (although their perceptions of it may vary) and the different individual situations they find themselves in. While students may perceive the workload is in general is not excessive, given their particular situation (perhaps due to part-time work commitments), they may perceive their workload as heavy and consequently adopt a surface approach to their learning. Therefore,

> It is not sufficient to develop a context which affords a deep approach to study. University teachers need also to determine how their students are perceiving their situation within that context.

(Prosser & Trigwell, 1999, p. 82)
The implications for good teaching practice involve a continuous awareness of:

- students’ present learning situations;
- the contextually dependent nature of teaching;
- students’ perceptions of teaching technologies used in teaching (including information technology);
- the student diversity in classrooms (including cultural diversity); and
- the need to continually evaluate and improve teaching (Prosser & Trigwell, 1999, p. 166).

These are key principles highlighting aspects that teachers, and by implication those who develop CFL materials and systems, need to bring into focus when constructing learning and teaching contexts.

Good teaching sees the relationship between learning and teaching as “problematic, uncertain and relative” (Ramsden, 1992, p. 102). It requires not only an understanding of the general principles of learning and teaching, but also careful and continuous monitoring of what students are experiencing in their learning situations; and awareness of the range of responses that can be made to emerging situations (Prosser & Trigwell, 1999, p. 168). Key factors in students’ perceptions of their situation are indicated, for example, by Ramsden’s Course Experience Questionnaire, which has been used in many studies of student learning (Prosser & Trigwell, 1999, p. 66). Each factor will have direct implications for thinking about the design of CFL materials, as indicated in Table 4.2.

Table 4.2 Students’ perceptions of their situation established by the Course Experience Questionnaire, with implications for CFL use

<table>
<thead>
<tr>
<th>Students’ perception</th>
<th>Example of question stem</th>
<th>Implications for the use of CFL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good teaching</td>
<td>Teaching staff here normally give helpful feedback on how you are going.</td>
<td>Provide immediate feedback, tutor hotline and effective channels of communication with teacher.</td>
</tr>
<tr>
<td>Clear goals</td>
<td>You usually have a clear idea of where you’re going and what’s expected of you in this course.</td>
<td>CFL activities are well integrated into course, contextualised and supported.</td>
</tr>
<tr>
<td>Appropriate workload</td>
<td>The sheer volume of work to be got through in this course means that you can’t comprehend it all thoroughly (scored negatively).</td>
<td>CFL activities should not be ‘on top’ of others. They might provide timesaving opportunities and not involve unnecessary cognitive load.</td>
</tr>
<tr>
<td>Appropriate assessment</td>
<td>Staff here seem more interested in testing what we have memorised than what we have understood (scored negatively).</td>
<td>Activities are well integrated into course assessment framework and allow opportunities for demonstration of higher-level skills.</td>
</tr>
<tr>
<td>Emphasis on independence</td>
<td>Students here are given a lot of choice in the work they have to do.</td>
<td>CFL activities may be flexibly accessible, provide selection of interactive case studies, or use a broad problem-based approach.</td>
</tr>
</tbody>
</table>

What works in a particular discipline, field of study or group of students may or may not work with another. Awareness of this contextual dependence requires a ‘student-centred’, rather than ‘teacher-centred’ approach to the design of the learning context and the principles that underlie good design apply regardless of the technology used (Prosser & Trigwell, 1999, pp. 168-9). A key issue in CFL is an understanding of the way in which students perceive the use of technology, although this is just one aspect of their overall perceptions of the situation.
Good teaching involves recognising the diversity in the student population, which will include an appreciation of different cultural backgrounds. For example, it is often argued that students from non-European backgrounds may appear to adopt surface approaches to learning; however, this may simply be a form of rehearsal with the intention to later engage in more meaningful approaches (Prosser & Trigwell, 1999, p. 169). The role of evaluation is vital, but this should include the ongoing monitoring of the way students perceive their situation. Identification of the variation in students’ perceptions can be facilitated by informal discussions with students, open-ended questionnaires or formal surveys, such as Ramsden’s Course Experience Questionnaire (Prosser & Trigwell, 1999, p. 170).

### 4.7 Overview of key points for academic learning

In the chapter so far, I have described models of learning from the literature that I believe are particularly relevant to the requirements of CFL Systems Development in higher education, address the complexity of the real learning problem and accommodate the perspectives of the students and teachers. Table 4.3 provides a pragmatic summary of key points that, like the Conversational Framework and the 3P model of student learning, provides a tool for thinking about the design and implementation of learning environments. Although drawn from empirical evidence of studies of student learning, these models make sense only when applied in a research-oriented teaching setting, in which a continual awareness of the individual student context is necessary to foster deep approaches to learning. Cross-references to relevant sections are listed.

**Table 4.3 Summary of key points about academic learning relevant to the field of CFL Systems Development**

<table>
<thead>
<tr>
<th>Approach:</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Philosophical belief</strong></td>
<td>The personal nature of understanding, importance of learning context. 4.2</td>
</tr>
<tr>
<td><strong>Outcomes</strong></td>
<td>Maximise deep approach to learning. 4.3, 4.5.2</td>
</tr>
</tbody>
</table>

**The context of learning and teaching:**

<table>
<thead>
<tr>
<th>Learning environment</th>
<th>Adjusted by the teacher to promote elements of active learning and appropriate perceptions of task. 4.5.1, 4.6.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students’ perceptions of their situation</td>
<td>Perceived good teaching, clarity of goals, reasonable workload, appropriate assessment encourages adoption of a ‘deep’ approach to learning. 4.6.2</td>
</tr>
<tr>
<td>Teacher as learner</td>
<td>Awareness of individual student’s perceptions of situation. Identifying misconceptions, learning approaches; reflecting on the teaching experience. 4.2, 4.3, 4.5.1, 4.6.2</td>
</tr>
<tr>
<td>The teaching environment</td>
<td>Supporting the teacher with rich views of the student experience, opportunities to adapt the learning environment and contribute feedback. 4.3, 4.5.1</td>
</tr>
</tbody>
</table>

**Student activities:**

| Articulation | Making tacit knowledge explicit. 4.6.1 |
| Feedback | Guidance, reinforcement, praise in response to articulation. 4.6.1 |
| Adaptation & re-articulation | Revising ideas in the light of new information, feedback or reflection. 4.6.1 |
| Relating parts to whole | Relating the detailed and big picture levels. Addressing broader goals. 4.6.1 |
| Theory to practice | Applying understanding to real-world problems, ‘authentic’ & ill-defined tasks. 4.6.1 |
| Reflection on learning | Tying together content goals, activities & feedback; consideration of the learning process. 4.6.1 |
I have found this summary helpful in discussions with teachers and in educational workshops. It draws attention to the notion that they are also learners, who need to continuously understand the different conceptions students may have of a topic, and the different perceptions of their situation which impact on the learning approach. In support of teachers, I emphasise that the quality of their working environment, for example, workload and resources available, needs to be actively addressed if student learning is to be improved.

4.8 Summary

This chapter provided an overview of research literature aligned with the field of CFL Systems Development from the perspective of learning. It began with fundamental assumptions about knowledge and learning, taking a constructivist worldview that emphasises the individual nature of knowledge and the social construction of meaning. From this view, learning cannot be separated from the context in which it occurs and hence both teachers and students are implicated within the learning process.

While traditional learning research attempts to establish relationships between variables in controlled experiments, phenomenographic studies focus on authentic learning situations and descriptions of phenomena emerging from retrospective accounts. These studies focus on the variation in conceptions and different approaches adopted by students in certain circumstances, rather than on explanations of learning or categorisation of students. This empirical research underpins the learning models examined in the chapter.

The nature of learning in the academic context requires interplay between practical application and theoretical discussion. It involves an interaction between situated or experiential knowledge and its conceptual representations through which ideas are communicated with others. Laurillard’s Conversational Framework models these experiential and conceptual components of individual knowledge and the iterative exchange that occurs between student and teacher as such knowledge is developed. The learning and teaching activity dialogue requires iterative processes of

- **discussion** between teacher and student at a conceptual level;
- **practice** by the student within an environment constructed by the teacher;
- **reflection** in the learner’s performance by both teacher and learner; and
- **adaptation** of the world by the teacher and actions by the learner.

This Framework provides a core structure from which traditional and CFL learning activities can be modelled and the necessary conditions for learning analysed.

The 3P model of learning and teaching also derives from research on student learning and focuses on the relationship between students’ perceptions of their situation and their adopted approaches to learning. Depending on their background experience, understandings, perceptions of the task, quality of teaching and real life situation, they may adopt a ‘deep’ or ‘surface’ approach to learning, which is related to the quality of the learning outcome.

Requirements for academic learning activities suggested by the Conversational Framework are that the student apprehends the structure of ideas, interprets descriptions, acts on the world, uses feedback and reflects on goals.
The relational model of learning focuses on setting the learning context by building perceptions of good teaching, setting clear goals, appropriate workloads and assessment and encouraging independence. The strong context dependence of learning requires that a ‘student-centred’ approach be adopted.

These requirements are summarised as a pragmatic set of key points about a philosophical approach, context of the learning and teaching situation, and micro-level student activities, necessary for learning of an academic nature that can inform CFL development and organisational perspectives.
CHAPTER 5. Perspectives on educational design and development

5.1 Introduction

In this chapter, I will examine perspectives in the literature on educational design and development. This follows from the review of perspectives on learning in Chapter 4 and examines the professional roles, standards and approaches espoused by various paradigms. This chapter provides a foundation for the examination of perspectives on the organisation in the Chapter 6 (Figure 5.1).

The review starts with the supposition that, similar to the process of learning itself, educational design and development are essentially problematic social activities, a point made in the background to this study. Multiple theories and models for development exist, representing a range of discipline and stakeholders perspectives and there will be no generalised approach suitable in every context.

Traditionally, professional fields such as instructional design have guided the design and development of CFL and traditional learning materials. These formalised approaches have increasingly been questioned in regard to their relevance to the new demands of higher education and ability to represent the less tangible social aspects of learning and workplace environments. It is appropriate, however, to start with an examination of traditional paradigms in order to follow their progress towards more human-centred approaches such as constructivism. The literature review draws on the learning perspectives explored in the previous chapter and introduces practical approaches reported in other disciplines, such as software development. Finally, the key points raised about learning in Section 4.7 is expanded into a pragmatic framework as a guide for this study and university teachers and developers producing CLF environments.

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Figure 5.1 The field of CFL Systems Development taking a perspective on educational design and development
5.2 Instructional Systems Development paradigms

Even in well-established fields such as instructional design or instructional systems development, there are no clearly accepted approaches to inquiry (Bain, 1999, p. 165; Reeves, 1997, p. 163; 2000). Indeed there are varying interpretations of what these fields actually mean (Dills & Romoszowski, 1997a, p. 5). While the role of ‘instructional designer’ carries with it a clearly established set of professional skills and practices, the broader fields of instructional development, or CFL Systems Development as defined in this study, have no equivalent role. Individuals working within these areas may be teachers, lecturers, software developers or instructional designers and will use skills, language and practices emanating from diverse professional backgrounds. That is, practice in the broad area of CFL Systems Development as defined in Section 3.3, must somehow relate to multiple paradigms and their associated perspectives, methodologies and professional communities. To understand the nature and evolution of these professional communities, it is useful to review the traditional model of instructional development, which has been influential in higher education over many years.

‘Instructional Development’ (ID) is a term covering a variety of meanings associated with professional activity in training and education. It can be defined as:

A self-correcting, systems approach that seeks to apply scientifically derived principles to the planning, design, creation, implementation, and evaluation of effective and efficient instruction.

(Dills & Romoszowski, 1997a, p. 5)

‘Instructional Systems Development’ (ISD) is another common term emphasising the systems view of this activity. ISD is generally seen as an objectivist model, characterised by clearly defined activities, for example, to determine needs; analyse goals, learners and settings; plan and design materials; and evaluate outcomes. The ability of ISD to adequately represent the complex and dynamic situations in which learning occurs, has been coming under increasing critical comment (see, for example: Coleman, Perry & Schwen, 1997, p. 281; Dorsey, Goodrum & Schwen, 1997, p. 446; Lent & Van Patten, 1997, p. 146; Wilson, 1997, p. 63). I have, however, included ISD as a ‘baseline’ perspective for this study because:

• ISD in its various forms has been a major influence in educational development for several decades;
• the ISD approach characterises elements of my thinking, particularly in the initial phases of the study; and
• the terminology and philosophies of ISD still influence thinking within universities.

5.2.1 The traditional instructional development model

Dick and Carey’s (1985) systematic approach to the design of instruction has been influential in the profession of instructional design for nearly three decades and perhaps best represents the commonly held view of ISD.

Instruction is viewed as a systematic process made up of components necessary for learning to occur (Dick & Carey, 1985, p. 2). The process of instructional development is approached as a system of interrelated tasks and the model stresses up-front identification of required student skills, measurement of those skills and subsequent revision of the instruction. Figure 5.2 represents the characteristic sequential model of planning, design, production and evaluation.
My conceptual starting point in this study focused on a similar set of interconnected tasks relevant to the university setting illustrated in Figure 1.3 (p. 10). Any structural similarity in terms of interlinked tasks and outputs is not altogether surprising, as the ISD model figured prominently in my prior training in instructional design. Elements of this model, such as needs analysis, curriculum goals, formative and summative evaluation, are common terminology within the university community, even if there is wide variation in their interpretation. More significantly, the basic development cycle of planning, designing, developing, and undertaking formative and summative evaluation remains a commonly adopted project approach within universities. It is fair to point out that more recent versions of this model include consideration of issues, such as contextual analysis, in recognition of the broader cultural contexts (Carr, 1997, p. 5; Tessmer & Richey, 1997, p. 86).

### 5.2.2 Constructivism as a link between learning theory and instructional development

The rapid evolution of information technology over the past decade is part of the reason for rethinking the ISD paradigm. The flood of information has caused industry to look towards ‘just in time’ training and skills that require the interpretation and application of information to solve real world problems, rather than static curriculum designs. In education also, there are calls for theme-based instruction, with students applying information from multiple disciplines to real world problems; “learning is seen to be situated in the work context, with the meaning derived from that context” (Duffy & Jonassen, 1992b, p. x).

Duffy and Jonassen (1992) have attempted to link instructional approaches and learning theory, using constructivism as a vehicle (Section 4.2). They highlight the divide between those who know about learning theory and those who undertake development, despite the clear overlap between the fields (Duffy & Jonassen, 1992b, p. ix). This is a question of ‘praxis’, the relationship between theory and practice. It is important also to acknowledge that the work actually carried out by instructional designers goes well beyond any formal knowledge set, particularly in solving unfamiliar situations, or working with innovative solutions. This tacit knowledge is derived from fundamentally different life experiences, although it can be strengthened by a research stance to practice (Duffy & Jonassen, 1992b, p. ix; Tessmer, 1990, p. 56).

A constructivist view of learning has major implications for all aspects of the instructional design process. Such realignment may even be considered revolutionary, rather than evolutionary, requiring a major
reconceptualisation of design practices and roles of designer and subject matter expert, as content and learning merge (Bednar, Cunningham, Duffy & Perry, 1992, pp. 30-1). Contrasting characteristics of the traditional objective ISD model and a ‘constructivist-interpretivist’ alternative are summarised in Table 5.1 (Willis, 1995 in Tam, 2000, p. 54).

Table 5.1  Comparison between Objective-rational and Constructivist-interpretivist ID models

<table>
<thead>
<tr>
<th></th>
<th>Objectivist-rational ID model</th>
<th>Constructivist-interpretivist ID model</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Design process</strong></td>
<td>Sequential and linear.</td>
<td>Recursive, non-linear and sometimes chaotic.</td>
</tr>
<tr>
<td><strong>Planning process</strong></td>
<td>Top down and systematic.</td>
<td>Organic, developmental, reflective and collaborative.</td>
</tr>
<tr>
<td><strong>Objectives</strong></td>
<td>Objectives guide development.</td>
<td>Emerge from design and development work.</td>
</tr>
<tr>
<td><strong>Expertise</strong></td>
<td>Experts, who have special knowledge, are critical to ID work.</td>
<td>General ID experts do not exist.</td>
</tr>
<tr>
<td><strong>Emphasis</strong></td>
<td>Careful sequencing and the teaching of subskills.</td>
<td>Learning in meaningful contexts.</td>
</tr>
<tr>
<td><strong>Goal</strong></td>
<td>Delivery of preselected knowledge.</td>
<td>Personal understanding within meaningful contexts.</td>
</tr>
<tr>
<td><strong>Evaluation</strong></td>
<td>Summative evaluation is critical.</td>
<td>Formative evaluation is critical.</td>
</tr>
<tr>
<td><strong>Data</strong></td>
<td>Objective data is critical.</td>
<td>Subjective data may be most valuable.</td>
</tr>
</tbody>
</table>

(after Willis, 1995 in Tam, 2000, pp. 54-5)

Traditional ID theories are prescriptive in the sense that they guide practice by providing recipes or heuristics for doing designs and specifying how end-product instruction should look (Wilson, 1997, p. 68). As procedural models, they have the appearance of rationality and professionalism, but their ‘fidelity’ to the real work situation is low as they fail to account for what instructional developers actually do (Dorsey et al., 1997, p. 445; Hannifin, Hannifin, Land & Oliver, 1997, p. 102; Rowland, 1992, p. 65). Postmodern educational developers question the assumption that such activity can be realistically defined by standardised processes and methods.

More critical approaches to instructional development take into account the personal experiences and cultural setting of the developers and educators and recognise that the uncertainty, ambiguity and chaos of cultural systems are necessary ingredients (Jamison, 1997, p. 82). They raise questions not traditionally asked by instructional developers, such as: “who benefits from instructional development?” and “what is wrong with the system?” From this perspective, the development system itself is a part of the world under investigation, as are the participants.

While the constructivist view has gained recognition in its interpretation of learning situations (Section 4.1), it provides additional challenges for developers. For example, assessment remains an important measure within the current education system, but is problematic in a constructivist learning environment, which may also prove difficult to evaluate and costly to produce (Tam, 2000, p. 58). With the curriculum focus placing more responsibility and control with the student comes a certain challenge associated with change that is experienced by both students and teachers.

Constructivism does provide an alternative view of learning and development; however, this does not mean that traditional linear, systematic views cannot be accommodated. An objectivist perspective simply tells one possible story that is, like others, open to critical interpretation and usefully triangulated by other views.
The challenge for the design community is to understand and evaluate the different perspectives, methods and assumptions appropriate to fundamentally different contexts.

(Tam, 2000, p. 58)

5.2.3 Rapid Collaborative Prototyping

While is easy to state the desirability of more human-centric approaches to development, how might they be achieved in practice? Rapid prototyping in software and information systems design has been a response to problems with traditional engineering methodologies, particularly due to the difficulty of specifying user requirements when the full nature of a complex system is not fully understood by either user or designer (Denning & Dargan, 1996, p. 108; Mason & Carey, 1983, p. 347; Pressman, 1997, p. 33; Schrage, 1996, p. 194). The working software prototype provides a particularly effective mechanism for specifying design functionality in a form understood by both designer and user (Kennedy, 1998, p. 379).

Given the similarities between software engineering and CFL design, rapid prototyping has been advocated as an instructional design methodology (Tripp & Bichelmeyer, 1999, p. 31). Potential advantages are that it encourages and requires active feedback from students and teachers; clients don’t know their requirements until they see them implemented; the prototype is equivalent to a paper specification, which can reveal errors more easily; it can improve creativity through rapid feedback; and it accelerates the development cycle (Tripp & Bichelmeyer, 1999, p. 42).

The process of ‘rapid collaborative prototyping’ is proposed as an alternative form of instructional development.

...rapid collaborative prototyping is an iterative process of design in which users and designers engage as peers to simultaneously discover the problem and solution through the use of prototypes to make ideas concrete.

(Dorsey et al., 1997, p. 448)

The process involves building a series of operational prototypes that are applied in real user tests. Through this experience, the problem definitions and solution requirements can be conceptualised, with additions and refinements incorporated into the next iteration (Figure 5.3, p. 52). This approach addresses the basic observation that most users are able to point out problems and missing features within an existing system, more easily than they can describe what they would like in an imaginary one.

This represents a return to craft-based, ‘trial and error’, or ‘design by doing’ processes, in which the problem and solution are simultaneously discovered by users. In contrast, the ‘expert’ approach of ISD separates designers from builders and users. In rapid prototyping the users are recognised as the experts in their area and are as well the ones who will have to live with the consequences of the design, long after the designer has vanished! Users are therefore rightfully active participants and share equal power in a context of mutual learning and discovery, even if this newfound equality of responsibility might prove problematic for both designer and user (Dorsey et al., 1997, p. 450). It is noted, however, that rapid prototyping methodology as it stands, does not point out what
should be developed or why, whether the designs should be limited to instruction, what should be included and who should be involved (Dorsey et al., 1997, p. 462).

![Diagram](image)

**Figure 5.3** Rapid collaborative prototyping (after Dorsey et al., 1997, p. 449)

While one of many possible development methodologies, rapid prototyping approaches are pertinent to this study. The iterative conceptualise-build-test process aligns well with the action research approach adopted in the software development methodology described in Chapter 7. Further, increased understanding of what actually happens in a real-world development is a specific goal of the study.

### 5.3 The design of academic learning conversations

The Conversational Framework for student learning process was introduced in Section 4.5.1. One means of applying this model to the design of supporting CFL environments is to examine the different media for their ability to support the necessary discursive, adaptive, interactive and reflective elements of the learning model (Laurillard, 1993, p. 100). While Laurillard’s analysis of print, television, video, hypertext, simulation, tutorial programs, tutorial simulations, audio and video conferencing is dated, the conversational model still provides a useful guide to teaching practice and CFL materials development. She suggests three principal stages in the design process:

- defining learning objectives;
- identifying student needs;
- designing the learning activities; and
- setting the learning context (Laurillard, 1993, p. 208).

#### 5.3.1 Defining learning objectives

The identification of what students are expected to be able to do is the starting point in the design of learning materials in any medium (Laurillard, 2002, pp. 182-3). Statements of general teaching aims, for example, that a student will be able to ‘understand’ a particular concept, represent the intentions of a course but are not sufficient to inform teaching strategy. More detailed learning ‘objectives’ are required to define more precisely the types of behaviour that would provide evidence that a student had indeed achieved the aim. This process of setting objectives and assessment measures a fundamental to the traditional instructional development model (Section 5.2.1). The setting of objectives will suggest the types of activities a student will have to engage in, but does not address the individual student needs and prior misconceptions they may bring.
5.3.2 Identifying student needs

In addition to knowing what they require students to achieve, teachers must somehow address the current forms of students’ understanding of a subject (Laurillard, 2002, p. 183). While indications of students’ conceptions can potentially come from examination results, these performance indicators tend to be an end in themselves. While assessment should be set in the context of the learning objective, students inevitably try to second guess what the teacher expects in order to achieve a good examination mark, rather than working through the content conceptions (Laurillard, 2002, p. 185).

The identification of student misconceptions is an important aspect of designing a learning environment that can pre-empt conceptual difficulties. A number of approaches that can be taken are summarised in Table 5.2. A simple misinterpretation of a technical term, for example, perhaps arising from confusion with its everyday meaning, may lead to more major inappropriate conceptual constructions. In many cases, student problems can be traced to a finite set of such misconceptions (Laurillard, 1993, p. 188).

Table 5.2 Ways of determining students’ conceptual difficulties within topic areas

<table>
<thead>
<tr>
<th>Through research</th>
<th>Phenomenographic research (Section 4.3) can establish a student’s conceptual structures through a process of post-learning interview, but is not necessarily a practical option for teachers.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Via assessment, assignments</td>
<td>These are valuable sources of information when these activities are carried out in the context of the learning objectives, rather than performance indicators.</td>
</tr>
<tr>
<td>Within tutorials and discussion</td>
<td>One-to-one discussion forms the best learning and teaching environment but is increasingly difficult to provide within the current university system. Larger group tutorials are useful, but may not reveal the problems of weaker students.</td>
</tr>
<tr>
<td>By the students themselves</td>
<td>Students can be encouraged to undertake teacher-student role-play activities in order to make their conceptions explicit to each other.</td>
</tr>
<tr>
<td>From research literature</td>
<td>Educational research and curriculum development experiences in particular disciplines are disseminated in various journals. Keeping up with these, however, is difficult for teachers already under time pressure. The quality of research varies widely.</td>
</tr>
</tbody>
</table>

Laurillard emphasises that while it may be difficult for teachers to undertake such kinds of inquiry, this knowledge is critical for effective learning designs. In spite of being, and perhaps because they are, extremely knowledgeable in their subject areas, it is difficult for teachers to step into the shoes of their students in order to understand the range of conceptual interpretations required to ‘pre-emptively adapt’ their teaching designs. Understanding the perceptions of students is also a key theme of relational approach (Section 5.4). One implication here is that learning environments should also be consciously designed in order to facilitate teachers’ understanding of their students’ misconceptions. Students’ workload also needs to be balanced across the demands of learning objectives, as determined by the needs analysis.

5.3.3 Designing learning activities

Once the learning objectives and what students bring to learning have been determined, creativity can be applied to bridge this gap using appropriately designed learning activities (Laurillard, 2002, p. 189).

The Conversational Framework represented in Figure 4.2 and Figure 4.3 provides a template for structuring the learning events for particular learning objectives (Laurillard, 1999, p. 115). It can be used to unpack the structure of the conversational transactions required for learning to occur, which can then be translated into appropriate forms, whether using traditional or CFL means. The first column in Table 5.3 represents the fundamental
elements of the conversation between learner and teacher described by the conversational model. Column two
describes the form of the micro-level actions that constitute the discussion at conceptual level, emphasising the
‘goal-action-feedback-modified action’ cycle represented by the activities 1 to 4. The same sequence is repeated
at an experiential (or practice) level and at the level of internal generalisation (Section 4.5.1). The remaining
columns suggest some real activities that would meet these requirements using either traditional teaching
approaches or new technologies.

Table 5.3 Design template for teaching and CFL based on the requirements of a learning conversation

<table>
<thead>
<tr>
<th>Conversational elements</th>
<th>Necessary micro-level activities</th>
<th>Traditional teaching approaches, e.g.</th>
<th>Possible CFL approaches, e.g.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discussion at conceptual level</td>
<td>1. Goal: describe teacher’s conception of topic.</td>
<td>Provide aims and objectives, main points, examples, definitions, evidence, processes, etc.</td>
<td>Provide online access to such course information.</td>
</tr>
<tr>
<td></td>
<td>3. Feedback: teacher’s reconception, pre-empting misconceptions.</td>
<td>Provide alternative descriptions and representations highlighting previously identified misconceptions.</td>
<td>Immediate feedback on exercises or delayed responses from tutors.</td>
</tr>
<tr>
<td>Interaction at experiential level</td>
<td>Provide series of experiential, interactive tasks with feedback.</td>
<td>Repeat tasks 1–4 in various applied settings.</td>
<td>Simulated ‘virtual’ environments, problem-based exercises or case studies.</td>
</tr>
<tr>
<td>Reflection and adaptation at conceptual and experiential levels</td>
<td>Reinforce prior interactive tasks, providing opportunities for reflection.</td>
<td>Repeat previous tasks 1–4 to draw out revised interpretations, resolve inconsistencies, etc.</td>
<td>Electronic learning portfolios for reflection. ‘Integrative’ exercises.</td>
</tr>
<tr>
<td>Reflection and adaptation of generalised representations</td>
<td>Reflect on specific conceptual knowledge and generalisations of action knowledge.</td>
<td>Repeat previous tasks 1–4 to draw out generalised interpretations, resolve inconsistencies, etc.</td>
<td>Topics on discussion forums to elicit students or outside experts experiences.</td>
</tr>
</tbody>
</table>

(after Laurillard, 1993, p. 195; 1999, p. 115)

The design template would be applied a several levels of description, from the learning of particular concepts to
a whole area of discourse. Although somewhat involved, it provides a way of mapping the necessary micro-
conversations for a learning engagement addressing a particular learning objective. This degree of detail is
totally appropriate when considering the qualities of the generic online learning system being developed within
this study.

5.3.4 Setting the context

While the micro-level activities that make up a learning environment are important, contextual factors are found
to directly affect the quality of student learning. These include:

- orientating the student towards the requirements, skills and ideas they are about to encounter;
- integrating new materials into the curriculum;
• supporting students’ conceptual development by demonstrating commitment, opportunities for students choosing their methods of studying, pedagogical support;
• assessment that is relevant to new types of learning and understood by students; and
• availability of resources including adequate means of support (Laurillard, 1993, pp. 211-20).

In other words, even the best-designed learning materials may fail if one or more of these factors are not addressed.

5.4 A relational model of teaching design

Variation in students’ perceptions of their situation, their approaches to learning and the importance of the learning context have been analysed in relational studies of student learning (Section 4.5.2). The question is now: what are the implications for teaching practice and for CFL Systems Development in this study? I will maintain here the focus of the literature on the ‘teacher-as-developer’, acknowledging that there is overlap between the roles of teachers and developers in the context of this study. University teachers are increasingly expected to be able to use new technologies in their teaching, rather than relying on expert support, and the principles that underlie good teaching practice apply equally to traditional and new technologies (Prosser & Trigwell, 1999, p. 169).

Relational research into student learning has been extended with studies of teachers’ prior experience and conceptions of teaching, indicating there are two qualitatively different approaches to teaching (Prosser & Trigwell, 1999, p. 22). One group exhibits a ‘teacher’ or content focus, with the intention to transmit information or content to the student. The other group focus on the student, with the intention to change the students’ conception of a topic. Only limited studies of teachers’ perceptions of their teaching situation have been undertaken, but the evidence suggests that those who perceive they have some control over what is taught and how it is taught, are likely to adopt a more ‘student-centred’ approach (Prosser & Trigwell, 1999, p. 22). This is also the case if they perceive that their workload, class size and the student diversity are not too great. The implication is that, if a CFL system is implemented in a setting in which the teacher perceives an excessive workload, perhaps due to external factors or extra work resulting from the change of delivery, then they may revert to a teacher-centred approach, regardless of how ‘good’ the CFL design.

The relational aspects of learning and teaching emanating from these studies are drawn together in a combined model shown in Figure 5.4. Teachers need to recognise that a student’s approach to learning in a particular situation and the outcome from their activities, are fundamentally related to their perception of the situation and the particular prior experiences this evokes (Prosser & Trigwell, 1999, p. 165). To affect good learning outcomes in students, the teacher must identify and address the perceptions of students of their learning situation, in order to adapt the learning context (plain arrow). Teachers must appreciate that, for example, students perceiving high workloads or assessment that encourages memorisation, are more likely to adopt a surface approach to learning, with direct consequences on learning outcomes. The dashed arrow indicates the critical reflective process for teachers to stand ‘in the shoes of the learner’.

55
Similarly, a teacher’s approach to teaching will be influenced by the way they perceive their situation, including their perceptions of leadership, attitudes, control of how and what is taught (Ramsden, 1998a, p. 64). Whatever their capabilities, a teacher perceiving increasing pressures on their time and little reward for their efforts, is likely to adopt the equivalent of a ‘surface’ or ‘teacher-focused’ approach to teaching or attempts at innovation. This is a critical point that is often ignored in the design of CFL environments. Consideration should be given not only to students’ perceptions, but also to teachers’ perceptions of, for example, staff workload, recognition, conflicting priorities (Fritze, Canale, Cunnington & Smyth, 2001) and the value placed on teaching by the institution (Prosser & Trigwell, 1997, p. 34). The best CFL system designs stand to fail if the teachers’ perceptions of their situation mean that they adopt the equivalent of a surface approach to their implementation. There are implications here for both educational design and development and organisational management, which has a responsibility for setting appropriate contexts in which teaching occurs. An organisational perspective will be examined in the next chapter.

Prosser and Trigwell (1999) propose principles of practice arising from the relational view of learning and teaching, suggesting that good teaching involves a continuous awareness of the following factors (Prosser & Trigwell, 1999, p. 166).

Students’ present learning situations
Good teaching is not about applying predetermined recipes and techniques, but is recognised as problematic, with each learning situation unique and requiring careful monitoring of what students are experiencing and responsive adjustment of teaching.

The contextually dependent nature of learning and teaching
What works in one learning and teaching context may not work in another.
Students’ perceptions of technologies used in teaching (including ICT)
Understanding the variation in students’ perceptions of the role of information technologies in learning and teaching is an area not given enough attention. The principles to encourage deep learning approaches apply to all teaching approaches.

The student diversity (including cultural diversity) in classrooms
Accommodating the variation in individual students’ experiences also includes cultural diversity. Certain approaches to learning are commonly associated with particular cultural backgrounds, although the students’ intentions may reveal another story (Prosser & Trigwell, 1999, p. 169).

The need to continually evaluate and improve teaching
Good teaching will involve attempts to ascertain individual students’ perceptions of their learning situation and adjustment of the learning context to evoke a deep approach to learning. To do this it is necessary to continuously monitor the approaches and perceptions of all students.

The above principles and the relational model of Figure 5.4 place the teacher and student at the centre of efforts to improve learning and teaching, whether or not these involve technology. This particular perspective on educational design and development supports many of the characteristics of the constructivist view of instructional development outlined in Section 5.2.2. Both espouse non-linear, organic and reflective design processes and emphasise the importance of meaningful contexts, personal understanding and formative evaluation that deals with subjective data. Both question too, the place of ‘expert’ designers existing outside the learning and teaching context.

5.5 A Pragmatic Educational Requirements Guide
The approaches reviewed in this chapter provide a selection of perspectives on the development of both traditional and CFL environments. Each offers a focus and guidance for the development process, the value of which will depend on the context of the development, the background experience of the participants and the nature of the undertaking. Taking a pragmatic approach, and for the purposes of guiding this study, the principal contributions of each is mapped in Table 5.4.

Given the context, purpose and goals of my study, the instructional systems development paradigm provides an important baseline model of development, well understood within the university environment. In a sense, the study traces my shift from a traditional systematic-expert paradigm, to an approach reflecting a constructivist viewpoint. Rapid collaborative prototyping offers an appropriate model of software development for the software production goal of the study, while the Conversational Framework specifies the micro-level interactions that need to be supported by the technology. Finally, the relational model not only establishes the importance of the personal situations of teachers and students to practical outcomes, but also offers a practical framework of key factors to be addressed.
Table 5.4 Principal focus adopted by different approaches to development discussed in this chapter

<table>
<thead>
<tr>
<th>Approach</th>
<th>Principal focus</th>
<th>Implications for development process</th>
</tr>
</thead>
</table>
| A. Instructional Systems Development (5.2.1) | What is to be taught? | • Objectives guide development.  
• Systematic plan-design-implement-evaluate process.  
• Content separated from instruction.  
• Developers are experts. |
| B. Rapid Collaborative Prototyping (5.2.3) | How can users and designers work in real settings? | • Cyclical process of development.  
• Goals change as understanding of implementation evolves.  
• Developers and users closely collaborate.  
• Prototype serves to specify requirements. |
| C. Conversational Framework (5.3) | What are the requirements of academic learning? | • Set up required activities for academic learning to elicit misconceptions and provide feedback.  
• Monitor variations in students’ conceptions of topic.  
• Teacher and student operate in discursive learning environment.  
• Analyse contribution of media and approaches. |
| D. Relational model of learning and teaching (5.4) | How do students and teachers relate to their situations? | • Monitor and respond to variations in students’ perceptions of their real situation.  
• Adjust learning environment to encourage perceptions that promote deep learning (student workload, assessment, good teaching, etc.).  
• Adjust teaching environment to encourage perceptions that promote deep teaching (teacher workload, recognition, good management, etc.). |

I have drawn together key factors from these approaches with key points from the learning perspectives in Section 4.7, to create a ‘Pragmatic Educational Requirements Guide’ for developing user-active learning environments (see Table 5.5, p. 59). The framework is organised under three key areas of learning context, teaching and development context and student activities necessary for ‘user-active’ learning, listing key points synthesised from the perspectives in the literature. Each key point is illustrated by examples of typical implementations and opportunities offered by new technologies. The ‘typical implementation’, makes no distinction in the mode of delivery, for example, ‘articulation’ might be achieved using either traditional or new technologies, such as writing, presenting, emailing or creating a student Web site. This is a pragmatic choice made by the teacher purely according to the learning context and resources. Unique ICT opportunities, on the other hand, highlight particular functionality afforded by technology, not otherwise possible, for example, a centralised electronic learning portfolio simultaneously accessible to both student and teacher.

It should be emphasised that these examples represent only a snapshot of thinking relevant to a particular context and time; even then it is an incomplete summary of possibilities. The framework is intended to be used within discussions with teachers or developers and to be adjusted to the relevant setting. For example, if used in a workshop for teachers from a particular institution, faculty and departmental area, the typical implementation and CFL opportunities would reflect appropriate terminology and include only examples relevant and accessible to that group. This guide represents a living document that reflects the spirit of the constructivist view of learning design and the real workplace, rather than providing a systematic process to be followed.
<table>
<thead>
<tr>
<th>Table 5.5</th>
<th>The Pragmatic Educational Requirements Guide for developing user-active learning and teaching environments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Key point</strong></td>
<td><strong>Typical implementation (traditional or ICT)</strong></td>
</tr>
<tr>
<td><strong>1. Learning context</strong></td>
<td></td>
</tr>
<tr>
<td>The learning environment</td>
<td>Creates conditions and opportunities for academic learning.</td>
</tr>
<tr>
<td>Students’ perceptions of their situation</td>
<td>Students’ perceptions of good teaching (and situation) encourage the adoption of a ‘deep’ approach to learning.</td>
</tr>
<tr>
<td><strong>2. Teaching and development context</strong></td>
<td></td>
</tr>
<tr>
<td>The teacher as learner</td>
<td>Recognise need to actively develop understanding of student misconceptions, learning approaches, experience of learning and reflect on the teaching experience.</td>
</tr>
<tr>
<td>The teaching environment</td>
<td>Supports rich views of the student experience, opportunities to adapt the learning environment and contribute feedback.</td>
</tr>
<tr>
<td><strong>3. Student activities necessary for user-active learning</strong></td>
<td></td>
</tr>
<tr>
<td>Articulation</td>
<td>Making tacit knowledge explicit.</td>
</tr>
<tr>
<td>Feedback</td>
<td>Guidance, reinforcement, praise in response to articulation.</td>
</tr>
<tr>
<td>Adaptation and re-articulation</td>
<td>Revise ideas in the light of new information, feedback or reflection.</td>
</tr>
<tr>
<td>Apprehending discourse structure</td>
<td>Managing detail within the structure of a broader argument. Relating the detailed and big picture levels.</td>
</tr>
<tr>
<td>Theory to practice</td>
<td>Applying understanding to real-world problems, ‘authentic’ and ill-defined tasks.</td>
</tr>
<tr>
<td>Reflection on learning</td>
<td>Tying together content goals, activities and feedback. Consideration of the learning process.</td>
</tr>
</tbody>
</table>
5.6 Summary

This chapter has examined a number of perspectives on the process of educational design and development. These are aimed at teachers, instructional designers, software developers or researchers, representing the multiple disciplines that inform the field of CFL Systems Development. While traditional instructional development paradigms still provide important frameworks for CFL development in universities, their capacity to deal with the less tangible social aspects of learning and workplace environments is questioned. The current rapid changes in higher education, technology and individual roles mean that the workplace context is characterised by uncertainty, conflicting paradigms and multiple perspectives. In this environment, approaches aligned with a constructivist philosophy reflect the importance of learning context, individual nature of learning and changed responsibilities of student and teacher. They also question the work actually carried out by developers, which goes beyond any formal knowledge set.

Rapid Collaborative prototyping emphasises an iterative design process in which users and designers engage as peers to simultaneously uncover problem and solution through the use of prototype implementations. Prototype solutions provide an important means of design representation, more easily comprehended by users than descriptions of an imaginary system. Rapid prototyping in software and information systems design fields has been applied to the design of complex and partially understood systems.

The design of academic CFL environments requires that teachers identify both learning objectives and the current forms of students’ understanding of a subject. Teaching therefore requires some degree of research to elicit students’ conceptual difficulties. The implication for CFL Systems Development is that both students and teachers’ learning should be actively supported, as reflected in Laurillard’s Conversational Framework, with which micro-level learning activities using either traditional or CFL approaches can be modelled.

The relational studies of student learning from the previous chapter have been extended to reveal a link between a teachers’ perception of their situation and the approach they adopt to teaching (or CFL development). Thus teachers may adopt a ‘teacher-focussed’, rather than ‘student-focussed’ approach, if they perceive increasing pressure on their time and few extrinsic rewards. In designing and implementing CFL systems, both students’ and teachers’ perceptions should be considered by CFL systems developers and organisational management.

The chapter concludes by drawing together emerging development themes with points from the learning perspective of the previous chapter, to provide a Pragmatic Educational Requirements Guide for developing user-active learning and teaching environments. While the teacher plays a key role in closely monitoring the perceptions and understanding of their students and in refining their teaching approach, it is clear that this is influenced by the nature of the organisational context, which sets workplace conditions and provides support and direction. It is this aspect of learning and teaching that will be explored in the next chapter.
CHAPTER 6. Perspectives on the organisation

Figure 6.1 The field of CFL Systems Development taking a perspective on the organisation

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6.1 Introduction

The processes of student learning and educational design and development do not occur in isolation, but within a broader organisational context. Students, teachers and developers do not follow fixed models of behaviour, but act according to their background experience, skills and perceptions of the organisational situation they find themselves in. Of particular interest to this study also is the notion that the implementation of any new system for learning and teaching will have a corresponding impact on the organisation, which must somehow adjust to “the intrusion of this new organism” (Laurillard, 2002, p. 214).

The assumption is made in this study that the relationship between individual activity and organisational context is complex and setting-dependent. Whatever organisational paradigms might be proposed, it cannot assumed that a single generalised approach will fully inform learning, teaching and CFL development in every situation. In this chapter the conceptual overview for the CFL Systems Development field defined for the study is extended with a review of research literature from the perspective of the organisation.

The chapter looks at organisational studies that reveal a changing workplace culture influenced by external and internal pressures. The way in which institutions respond is examined as a process of individual and organisational learning following directly from models reviewed in Chapter 4. The process of educational design and development from Chapter 5 is then reconsidered from an organisational perspective, through studies of innovation, diffusion and adoption.
Finally, a relational model for learning, teaching and development is drawn from themes emerging over the three chapters of the literature review, to provide a guiding framework for the study.

### 6.2 The changing organisational culture of universities

Research into management policy investigates the manner in which organisations deal with an increasingly complex and changing global environment. Universities are having to manage mass education, increasing competition, changing needs of students and reduced public funding (Ramsden, 1998b, p. 3). At the same time, new technologies are altering our conceptions of teaching, learning and workplace, for example, to accommodate new campus-based and virtual modes of teaching. Despite increasing pressure to undertake research, academics will be expected to master use of information technology, design curricula, evaluate and improve their teaching, improve assessment and feedback, teach more diverse groups, monitor evaluations made by students and graduates, meet employer demands and to understand and use new theories of learning (Coaldrake, 1999, p. 4).

Such changes are making it “impossible to administer huge organisations in the old, unwieldy, ‘collegial’ way” (Scott 1995 in Ramsden, 1998b, p. 5). The traditional collegial university model, with its academic autonomy and professional self-determination, does not lend itself to efficient adaptation of new educational technology in a commercial world. As universities become larger and more complex organisations, there is recognition of the need for specialist management functions that have been carried out for too long in an amateur fashion by academics, or considered not important to the ‘real’ work of universities (Coaldrake, 1999, p. 4).

The traditional collegial university is shaped by loose definitions of university policy and control of policy implementation (McNay, 1995, p. 105). Other forms of management culture reflect different policy and control parameters, related to the historical context, mission, leadership style and external pressures within particular institutions (Figure 6.2).

![Figure 6.2](image-url)  
*Figure 6.2 Models of management cultures in universities (after McNay, 1995, p. 106)*

Characteristics of the four organisational types revealed in the McNay model are outlined below and summarised in Table 6.1.
Table 6.1  Summary of characteristics of university organisational types

<table>
<thead>
<tr>
<th></th>
<th>Collegium</th>
<th>Bureaucracy</th>
<th>Corporation</th>
<th>Enterprise</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>Freedom to pursue university and personal goals unaffected by external control.</td>
<td>‘Managerialism’, focused on regulation, consistency and rules.</td>
<td>Tight control over policy and implementation. Crisis driven, competitive ethos.</td>
<td>Focus on competence. Orientated to outside world, espouses continuous learning in turbulent world.</td>
</tr>
<tr>
<td>Standards</td>
<td>Set by international scholarly community.</td>
<td>Related to regulatory bodies and external references.</td>
<td>Related to organisational plans and goals.</td>
<td>Related to market strength.</td>
</tr>
<tr>
<td>Dominant organisational unit</td>
<td>Department.</td>
<td>Powerful cohort of senior administrators.</td>
<td>Loyalty to organisation and senior management.</td>
<td>Small project team.</td>
</tr>
<tr>
<td>Students</td>
<td>Apprentice academics.</td>
<td>Seen as statistics.</td>
<td>Units of resource and customers.</td>
<td>Seen as clients and partners in search for understanding.</td>
</tr>
</tbody>
</table>

(after Ramsden, 1998b, p. 5)

In the collegium, the main university activities of teaching and research occur within the department and under a framework of peer accountability. It can be conservative and may not work except in small organisations. This is a view of the traditional university. In the bureaucracy, regulation and administrative oversight are used to obtain efficiencies from standard operating procedures. The decision time-cycle is good for stability but it cannot respond to rapid changes. The corporation is characterised by power, political processes and executive authority flowing from the vice-chancellor through appointed committees and working groups. Policy-makers are separated from reality, with collaboration between teachers and managers breaking down, leading to a culture that tends to be crisis-driven.

The enterprise culture is responsive to the requirements of the market place users of the university services. It provides one possible model for developing university leadership, which is consistent with both traditional academic values and with the fresh hazards facing universities (Ramsden, 1998a, p. 264). Key decisions are made close to the client, using the professionalism and skills of experts, but made within a general policy framework of the organisation. It recognises current resource constraints and accountability, but can respond to diverse community learning needs. A danger of the enterprise model is that curriculum adaptation may lose continuity and coherence when too closely connected to market opportunities and fashions (McNay, 1995, p. 106).

McNay suggests that institutions may tend to progress from collegial, through bureaucratic, corporate to enterprise structures, although there are wide variations and rates of change observed between institutions. The model can also be applied at a national level to educational policy of governments (McNay, 1995, pp. 111-2). Most significantly, there is evidence from senior staff in both Australian and UK institutions of a steady decline in the culture of the collegium, as part of the trend to larger, more diverse institutions dealing with new core functions such as technology transfer, flexible learning and continuing professional development (Ramsden, 1998a, pp. 34-5). Professional managers now work along side academic and administrative staff within more bureaucratic institutions, for example, within new pro-vice chancellor positions. In larger institutions, the
bureaucratic managerial approach starts to break down and some form of more devolved power in structured business units of some kind, with senior management synthesising strategic vision and developing a sharing culture. It would appear that firstly, we are unlikely to return to the collegial management model and secondly, neither bureaucratic regulation nor the centralised authority of the corporate model will provide sustainable leadership for tomorrow’s academic department (McNay, 1995, p. 110; Ramsden, 1998a, p. 36).

This picture of changing organisational culture of universities has implications for staff having to adjust their working cultures and approaches. At present, despite increasing pressures and decreasing levels of satisfaction, the intrinsic interest of academic staff in their work remains strong (McInnis, 2001, p. xiii). University leaders urgently need to recognise and harness this motivation by putting in place responsive structures to deal effectively with the changing environment. Characteristics of an effective structure developing from an enterprise culture have been suggested (McNay, 1995, p. 114):

- small, task-focused work units;
- giving each unit economic and managerial control over their own destiny;
- interconnecting with larger entities through ‘benign’ computer and communication links; and
- bonding into larger organisations through strong cultural bonds.

There are similarities between the enterprise university and the ‘entrepreneurial’ university described by Burton Clarke (Clark, 1998). It is critical to “rebuild the collegial spirit within departments and faculties” and to facilitate joint participation of academic staff and administrators in a strengthened steering core (Clark, 2001, p. 18). He stresses the importance of an ‘entrepreneurial narrative’ that depicts to public and patrons how new and traditional practices can contribute to the responsive modern university (Clark, 2001, p. 21). This is needed to counteract the tendency to treat universities like any other business, pursuing economic efficiency and accountability under centralised management. Such a narrative facilitates the design of complex interconnected social structures, by sharing stories that foster reflection and deeper understanding by participants in the process, as well as those outside the organisation. Individual perspectives are promoted within a holistic narrative that maintains multiple levels of meaning (Gill, 2001, p. 343).

The implications of these changes in university culture, for individuals and for the development of more flexible modes of learning and teaching using ICT, are profound. For example, more holistic approaches to evaluation must be undertaken in order to monitor these evolving workplace and organisational contexts that shape the learning and teaching environment. What is required is a holistic view of an institutional system that can maintain the strength of collegial expertise, while seeking to maximise the knowledge generated for the wider organisation. ICT systems, such as the generic learning system in this study, have the potential to facilitate learning and teaching while maximising the potential for diffusing ideas and products more widely.

### 6.3 The learning organisation

The organisational model above offers a broad view of the variation and change in university culture as characterised by various alignments to management policy and implementation, but reveals nothing about the
functioning of organisations as networks of interconnected individuals. Two models of organisation operation are examined below.

6.3.1 **Interpersonal behaviour within the organisation**

The organisational learning theory of Argyris and Schön begins with the notion that individuals have mental maps or personal theories of how to act in certain situations (Argyris & Schön, 1974, 1978). These represent ‘theories of action’ and include the values, strategies and underlying assumptions that inform individuals’ patterns of interpersonal behaviour (Schön, 1987, p. 255). ‘Theories of action’ operate at two levels. ‘Espoused theories’ are used to justify and explain action to others, while ‘theories-in-use’ represent usually tacit understandings and are implicit in behaviour. For example, an organisational manager may espouse policies of openness and freedom of expression, but in practice may systematically withhold or soften information that may be considered negatively.

Governing variables, which include the individuals’ values and assumptions, shape the strategy they adopt in a given situation and hence the consequences of that action. Learning occurs when theories-in-use are adjusted in the light of experience through some process of feedback (Figure 6.3).

![Figure 6.3 Argyris and Schön’s model of inter-personal behaviour (after Smith, 2001)](image)

In the simplest case, ‘single-loop’ learning occurs when the individual focuses only on how best to achieve goals and objectives that are considered external to the feedback loop (Argyris & Schön, 1978, p. 21). In certain situations, single-loop learning will fail to resolve a problem, resulting in a conflict between the elements of the individual’s theory-in-use. The individual may resolve the situation by becoming defensive, screening out criticism and putting the blame on others. This is an example of a common problem in organisations attributed to the ‘defensive routines’ adopted by professionals and senior staff (Argyris and Schön in Martin, 1999, p. 88). ‘Double-loop’ learning, on the other hand, involves questioning the governing variables, that is, the underlying principles and assumptions of a situation. It is associated with individuals opening up to criticism, discussing concerns and alternatives, trying to see the problem in another light and letting go of blame, before they adjust their strategy (Martin, 1999, p. 88).

Argyris and Schön have used empirical research in organisational settings to describe models of interpersonal behaviour, especially applicable to situations of difficulty or stress (Schön, 1987, p. 256). ‘Model I’ behaviour reflects the defensive response associated with single-loop learning and actively inhibits double-loop learning. ‘Model II’ behaviour, on the other hand, is characterised by double-loop learning, debate and questioning, with individuals and groups reflecting critically on their aims, goals and processes of working (Martin, 1999, p. 56). Individuals may readily espouse such values when questioned; however, it is easy for them to revert to a
defensive Model I-type actions when put under pressure. Institutions need to create conditions that encourage a transition from Model I to Model II behaviour, for example, through staff development programs to develop capacities for reflective practice, or facilitating community support networks.

The above models have focussed on individual behaviour and knowledge, but similar characteristics can be attributed to organisations (James, 1998, p. 47). ‘Espoused theories’ are found in the strategic plans and policy statements of organisations, while the theories-in-use of an organisation are represented by a complex system of strategies, assumptions, communication, support and control processes. Such organisational theories influence the actions of individuals, shaping their theories-in-use (Argyris and Schön 1974 in James, 1998, p. 48); however, no organisational learning occurs without individual learning. That is, individual learning is a necessary, but insufficient condition for organisational learning.

Argyris and Schön’s theories-in-use and espoused theories have similarities to Laurillard’s model of experiential and conceptual knowledge (Section 4.4). Both imply a constructivist view of learning emphasising the active role of the individual in on-going construction of understanding of the world. The adoption of a Model I or II behaviour by staff also parallels the adoption of a surface or deep approach to learning by students (Section 4.5.2), depending on the context and understanding of a given situation. The surface/Model I approach is a response to an immediate problem, requiring the least reflection on wider issues or conceptual adjustment, while the deep/Model II approach exposes conflict with existing knowledge or personal theories that require effort to reconcile.

6.3.2 A Conversational Framework for the learning organisation

For an organisation to learn, some internal dialogue must be conducted that allows it to reflect on its experience and adapt to its environment. Laurillard proposes that such a process is likely to mirror the logical structure of learning by an individual and that the Conversational Framework (Section 4.5.1) can be applied to the learning organisation (Laurillard, 1999, p. 5; 2002, p. 215). A test of the usefulness of such a model is to interpret each part and use the interpretation to constructively challenge the running of the university.

Figure 6.4 illustrates the resulting Conversational Framework for a learning organisation as various institutional activity nodes and the information that passes between them. Dialogue at a level of practice occurs across the bottom row through the activities of teachers, tutors and developers, as course activities are developed, implemented and evaluated, resulting in revisions to plans and designs for further courses. Similarly, the experience of each unit is communicated to the various committees, informing further development of the university’s system of learning and teaching and specific policy and management mechanisms. By reflecting on the organisational entities and their shared dialogue, institutions can identify the paths through which the core university experience of faculty academics can inform and be supported by strategic policy and management mechanisms.
The fundamental principle of the Conversational Framework is that at every activity node, a goal-action-feedback-revise action cycle should be evident (Laurillard, 2002, p. 216). Thus for every level there needs to be some meta-level function that monitors and reflects on the process, in order to bring about improvements at that level. Where these reflective conversations are absent, some breakdown in the effective operation of the organisation will occur. For example, many pilot CFL design experiments have been conducted in isolation from institutional management processes and have not contributed effectively to the long-term reconceptualisation of the institution’s learning and teaching strategies (Laurillard, 2002, p. 216).

The core conversation for the university is that between teacher and student. This can be represented in an expanded form of the teacher’s level of practice identifying and responding to the student’s learning needs and their attempts to improve understanding by reflecting on this. Professional development course activities might be incorporated into this framework, providing another level of discourse and resources on educational theory and practice. This form of analysis can be repeated at different levels within the organisation, through individual academics, tutors, course teams, educational designers, departmental and faculty groups, university committees and so on. It is argued that the generation of integrative knowledge through the problematising of teaching and critical reflection on experience at all levels, is fundamental to the learning organisation. Seen this way, the framework becomes a lens through which to confirm the requisite organisational structure to support the conversion of tacit and articulated knowledge, iteratively occurring between different levels of the individual and group.

The complete process for adaptive organisational learning can be represented as a succession of knowledge management activities linked by an iterative flow of information that occurs between them, as indicated in Figure 6.5 (Laurillard, 2002, pp. 219-220):
Tasks associated with each activity in Figure 6.5 are assigned to all levels of both academic management (such as, vice-chancellors, deans or unit directors.) and academic teaching (such as, teaching academics, course teams or teaching committees). For example, individual staff keeping up with research literature, visits organised between institutions and collection of market intelligence, all contribute to an expanding institutional knowledge base. Much of this remains tacit, however, and purposeful activity is required to facilitate the sharing of this knowledge, through seminars, professional development, etcetera. With this grounding in understanding, ideas can be made explicit through new innovative management programs and learning projects. These are refined through an iterative process of feedback from evaluation, before wide scale implementation of learning products, ICT systems, etc., and validation of its efficacy is undertaken.

Of particular interest to this study is the process of innovating, which is at the core of the university’s culture and competitive advantage, in both research and teaching. The innovative curriculum projects underpinning the development of the generic learning system in this study are a direct result of funding programs that are themselves a management innovation.

### 6.4 Innovation and diffusion

Innovation and diffusion theories offer another organisational perspective that can inform the development and implementation of CFL. In education, the term ‘innovation’ is often used interchangeably with ‘change’ and may refer to a planned process of improvement or problem solving at the level of individuals, courses, departments, institutions or higher education as a whole (Hannan & Silver, 2000, p. 10). It may represent new approaches to curriculum designs and institutional policy, although it is increasingly associated with the application of technology in teaching. Professionals in the field of educational technology act as change agents, as they work to introduce concepts, procedures and products that are often foreign to those with whom they work (Ely, 1999, p. 23).
There is a general assumption that an innovation will be adopted by members of an organisation as its advantages are recognised and the necessary support is provided. Addressing such a process requires not only consideration of the institutional setting, but also individual interests. Innovation is a “product of people interacting with people, in contexts that include institutional structures and disciplinary as well as institutional cultures.” (Hannan & Silver, 2000, p. 11). With increasing pressures on the higher education system, it is becoming increasingly difficult for the individual to innovate outside some form of organisational framework, since funding, academic reputation and even professional survival may depend on working within them (Hannan & Silver, 2000, p. 1). It must be acknowledged that a system development, such as the generic online learning system in this study, interacts with the broader organisational setting it seeks to influence.

6.4.1 A generalised model of diffusion

The concept of new ideas or innovations ‘diffusing’ into a community is found in many discipline areas, such as rural sociology (Rogers, 1995, p. 52), health (Rogers, 1995, p. 66), marketing (Rogers, 1995, p. 79), education (Rogers, 1995, p. 63) and educational technology (Ely, 1997; Holloway, 1996; Surry & Farquhar, 1997). The most widely quoted framework for diffusion research is that of Rogers (1995), which will be examined here and related to studies in educational technology in Section 6.4.2.

Rogers defines diffusion as “the process by which an innovation is communicated through certain channels over time among members of a social system”, where an innovation is an idea, practice or object perceived as new by the target of adoption, whether an individual or other unit of adoption (Rogers, 1995, p. 10). The manner in which an innovation is adopted into a social system is found in many empirical research studies to display an S-shaped relationship between the number of adopters and time of adoption (Figure 6.6).

![Figure 6.6](image)

*Figure 6.6* The process of diffusion by which innovations are adopted at different times by different members of a social system (after Rogers, 1995, p. 11)

The diffusion curves in Figure 6.6 indicate a slow initial uptake by a few individuals, some critical point at which ‘take-off’ occurs and finally a tailoring-off as saturation is reached. Innovations perceived by individuals as more relevant or accessible will display a steeper curve corresponding to a more rapid rate of adoption. Rogers acknowledges that an innovation may not be desirable for all potential adopters depending on different situations (Rogers, 1995, p. 12); however, there is an implication that a ‘successful’ innovation is one that diffuses widely across a social system. He recommends that “unsuccessful” innovations, where the rate of
adoption has plateaued, should be investigated to reveal the underlying reasons for rejection or discontinuance (Rogers, 1995, pp. 107-8). In the educational area, some technology innovations, such as the use of email, may well be expected to extend to most teachers; however, a particular CFL system may suit only certain discipline or teaching situations, a decision made by teachers themselves.

The findings from many research studies show that individuals differ in their ‘innovativeness’, that is, the degree to which an they adopt ideas earlier or later than other members of a given community (Rogers, 1995, p. 252). Rogers identifies five idealised categories of adopter: ‘innovators’, ‘early adopters’, ‘early majority’ and ‘laggards’, according to their position within the bell-shaped distribution curve of relative uptake time (Figure 6.7).

![Figure 6.7](image)

Figure 6.7 ‘Innovativeness’ as measured by the time at which an individual adopts an innovation (after Rogers, 1995, p. 262)

Research studies indicate dominant characteristics of the different adopter categories in terms of their socio-economic status, personality variables and communication behaviour.

**Innovators** are described as ‘venturesome’, with an interest or even obsession with new ideas and willingness to engage in daring and risk (Rogers, 1995, pp. 263-4). They require the ability to understand and apply complex technical knowledge and will benefit from resources and support, enabling them to absorb the possible loss from unsuccessful attempts. They may not always be respected by other members of the community and tend to establish relationships among other innovators outside the local group. Innovators play an important gatekeeping role in importing ideas from outside a social system’s boundaries.

**Early adopters** are more integrated into the community and provide opinion leadership and advice as to the merits of new ideas. They are respected by their peers and serve the important role of decreasing uncertainty about the idea and conveying a subjective evaluation of the innovation to peers through inter-personal networks.

Of the more mainstream population, the **early majority** are deliberate in their willingness to adopt innovations, but seldom lead. They represent a third of the population and play an important link in the diffusion process. The **late majority** are more likely to be sceptical and may be driven to adopt an innovation through peer or economic pressure. Any doubts about the innovation should be removed before they feel it safe to adopt. **Laggards**, acknowledged as a problematic term (Rogers, 1995, p. 266), are the last to adopt. Rogers points out that, from another perspective, laggards may actually be seen as innovators. For example, individual farmers labelled as
'laggards’ by their neighbours eagerly adopting new chemical farming practices in the 1950s, would now be viewed as ‘innovators’ in organic farming (Rogers, 1995, p. 185). The small amount of research on personality variables suggests that innovators, in comparison with later adopters, are capable of greater empathy, have greater ability to deal in abstractions, greater rationality and intelligence, a more favourable attitude towards change and are better able to cope with uncertainty and risk (Rogers, 1995, pp. 272-3).

Characteristics of an innovation perceived by members of the target population help determine its rate of adoption (Rogers, 1995, pp. 15-16). The five characteristics found to be most important are its relative advantage, compatibility, low complexity, trialability and observability. The relative advantage of an innovation may be perceived in different ways, such as economic value, social prestige, convenience or personal satisfaction. Innovations compatible with existing values, past experience or needs of potential adopters will not require adaptation to value systems. Similarly, simple ideas will be more rapidly adopted that complex ones. The ability to trial or experiment with an innovation will lessen the associated uncertainty. Finally, innovations that are relatively visible to potential adopters are more likely to be taken up. It is the potential adopter’s perceptions of these characteristics that are important, rather than any objective measure. In addition, the perceptions of the different adopter categories are likely to take different forms. For example, innovators are likely to come across new ideas through their connections outside the local community, see them as less complex due to their particular skills and have more desire to investigate and experiment than will someone within the mainstream categories. The very strong inference here is that ‘change agents’ should consider using multiple approaches to motivation, support or management appropriate to each sub category (Rogers, 1995, p. 275).

Early diffusion studies tended to treat adoption as a clearly defined behaviour that was replicated progressively across a community (Rogers, 1995, p. 174). Many innovations are, however, ‘re-invented’ by the user during the process of adoption and implementation. Such flexibility can enable an innovation to be customised for local conditions or in response to new problems that arise, strengthening its likelihood of success (Rogers, 1995, p. 177). On the other hand, such effects may come about through a failure in communication and may be seen as a failure in quality control, associated with an attitude that instructional materials can be ‘teacher-proofed’ (Wilson, 1999, p. 16). The critical point about re-invention is that this draws the actions of the user into the equation, not just their intention to adopt or not. Adoption of an innovation can thus be considered a process of social construction (Rogers, 1995, p. 179).

There is some evidence also that the process of individual adoption is not an instantaneous act but goes through different stages (Rogers, 1995, p. 162; Wilson, Dobrovolny & Lowry, 1999, p. 27). Rogers describes a five-step model of the ‘innovation-decision’ process. This commences with the ‘knowledge’ stage, in which users find out about an innovation; ‘persuasion’, at which point adopters form positive or negative impressions; ‘decision’, when the innovation is actually adopted or rejected; ‘implementation’, where it is used; and ‘confirmation’, when the adopter seeks further information and ratifies or discontinues use of the innovation (Rogers, 1995, p. 162). Most diffusion research, however, has focused on variance between data gathered from one-shot surveys, rather than using more qualitative methods that would explain the causes and sequences of events necessary for a dynamic perspective (Rogers, 1995, p. 188).
Much diffusion research has also neglected the consequences or effects of adopting innovations (Rogers, 1995, p. 409). To learn more about the process we need to examine more that just whether an innovation has been adopted or modified, for example, was seen as desirable or undesirable? was it adopted directly or indirectly? and were effects anticipated or unanticipated? (Rogers, 1995, p. 412) Unfortunately, diffusion research is often sponsored by agencies focused on measurement of the extent of adoption, who simply assume the innovation will lead to desirable consequences. Such measurement employs survey approaches, which are inherently more manageable than broader impact studies (Rogers, 1995, p. 409; Wilson et al., 1999, pp. 26-7). The study of consequences may require observations that extend over years or more in-depth case studies. These tend to yield idiosyncratic and descriptive data that are difficult to generalise and apply to other systems.

When seeking a richer picture of effects, it must be recognised that the value judgements of individuals are both incomplete and relative to the particular needs and values of the individual. Not only must the perspectives of different individuals be taken into account, but also that these may develop over time. To overcome a ‘pro-innovation’ bias and understand the idiosyncratic and situated nature of adopter behaviours, it is necessary for the researcher to be capable of taking their various points of view and for data to be gathered from adopters at various stages of the process (Rogers, 1995, p. 106). It should be stressed again that it is the perceptions of their situation that are important to the actions and decisions of users, rather than any objective value judgement (Rogers, 1995, p. 111).

### 6.4.2 Dissemination and instructional development

Instructional product development models do not always consider the process of adoption, and if they do, it tends to be only after the product is developed (Surry & Farquhar, 1996). For example, the traditional Research Development and Diffusion paradigm (RDD) that dominates the field of instructional development emphasising the separation of technical product design and implementation, has proven inadequate in the task of producing products that people want to use (Surry & Farquhar, 1996). This ‘technology-push’ is based on the belief that technology will result in inevitable improvement, akin to the previously discussed pro-innovation bias (Wilson et al., 1999, p. 26).

The movement to constructivist learning environments and communities (Section 5.2.2) indicates that learners and teachers are increasingly expected to assume greater responsibility for the shaping the learning process (Wilson, 1999, p. 12). That is, questions of use and adoption are beginning to merge with the design process itself and participatory design approaches that involve the teacher from the beginning will increase the likelihood of successful implementation. Such approaches may also address the frustrations associated with rapid change in organisational environments and technology, where a new process or innovation comes on the heels of the adoption of the previously ‘new’ process or innovation (Carr, 1997, p. 6).

Various mechanisms incorporating social factors into instructional development to facilitate implementation and adoption of products have been proposed. ‘Adoption analysis’, ‘environment analysis’, or ‘contextual analysis’, carried out during the initial analysis phase identifies key individual and organisational factors likely to influence the product’s adoption (Carr, 1997, p. 5; Surry & Farquhar, 1996; Tessmer, 1990, p. 55; Tessmer & Richey, 1997, p. 85). User characteristics, perceptions of potential adopters, the physical setting and support systems are analysed in order to influence the designs from the earliest stage. One example is the Concerns Based Adoption
Model (CBAM), in which change facilitators seek to understand change from the viewpoint of those who will be affected by such change, in order to bring about systemic restructuring of the organisation (Hall and Hord 1987 in Surry & Farquhar, 1997).

Ely (1999) has summarised eight conditions that appear to facilitate the implementation of educational technology innovations emerging from studies of successful innovations across a variety of settings (Ely, 1999, pp. 24-25):

- dissatisfaction with the status quo;
- existence of knowledge and skills;
- availability of resources;
- availability of time;
- rewards and incentives;
- participation though shared decision making and communication between all parties;
- commitment demonstrated by endorsement and continuing support offered by the organisation; and
- leadership, both at management and project levels.

While these conditions serve as useful indicators and guidelines (Surry & Ensminger, 2002), it is noted that the strength and importance of each condition depends on the context and innovation itself (Ely, 1999, p. 26). Formative evaluation using feedback from users in real settings can also inform design (Surry & Farquhar, 1996). This is reflected particularly in methodologies such as rapid prototyping (Section 5.2.3) or action research (Holloway, 1996, p. 1124).

It would appear that it is perhaps less a matter of which diffusion model is used, but how it is applied that will determine the nature of insights into the adoption and implementation of CFL (Wilson et al., 1999, p. 24). The use of any model will tend to constrain thinking and lead to misreading of situations and local needs. For example, the initial need for change may be driven by concerns reflecting only certain interests in the organisation, such as those of management to increase numbers of teachers using technology, with consequent impact on the direction of change effort. Further, organisations that have made a commitment to change find that existing momentum can override any attempts to slow or reconsider the decision (Wilson et al., 1999, p. 27). Change should be seen as a cultural shift at the individual level and in the context of the setting in which innovation occurs:

"The perceptions of the teachers, students, and other stakeholders in the process, their real reasons for use and non-use, require research that is reflective, grounded and open."

(Holloway, 1996, p. 1130)

**6.4.3 CFL innovation in universities**

For example, a major evaluation of nationally funded information technology projects in Australian universities between 1994 and 1995 found only a small number of CFL projects reported being adopted in other institutions (Alexander & McKenzie, 1998, p. 250). The study notes that even a project with the most appropriate learning design will not necessarily succeed, if for example, students’ perceptions of assessment do not align with the new learning process. In addition, many projects were developed by individuals out of a concern for their students’ learning, not always shared by their departments or faculty, or supported by department or faculty strategic plans (Alexander & McKenzie, 1998, p. 250).

Another national study found that there was little evidence of widespread diffusion or sharing of knowledge about the development and use of CFL beyond the boundaries of individual projects (McNaught et al., 2000, p. 74). Even though institutional mechanisms encouraged dissemination, there was little evidence that this was successful in informing potential adopters. Analysis of survey and case study investigations revealed three major themes influencing the dissemination and uptake of CFL in higher education (McNaught et al., 2000, p. 71). These themes were culture, including such factors as collaboration, motivation, staff rewards and time, leadership, learning and teaching models; policy, including alignment of policy throughout the organisation, direction of policy change (top-down or bottom-up), strategic policies such as funding and intellectual property; and support, including IT, library and administrative infrastructure, student support, educational design support for teachers, grant schemes (Figure 6.8). Certain of these factors overlap; for example, funding is a consistent presence in each theme.

![Figure 6.8](image)

Figure 6.8  Major factors affecting the adoption of CFL (after McNaught et al., 2000, p. 71)

The majority of factors related to the institutional level, for example, policy, infrastructure, resourcing, culture and support. Others were associated with personal attitudes or motivations to adopt, or were applied at a higher level of the higher education sector, through the use of broad policies, national databases or collaboration between institutions. Intellectual property issues, such as copyright, were found to be complex and impacted in different ways according to the context, for example, through personal attitudes and expectations, institutional policies or procedures, or national legislation for the whole higher education sector.
Again, the importance of context emerges:

It would, however, be an over simplification of the complexity of the situation to categorise specific factors and issues as either a barrier or facilitator to uptake. While some generalisations could be made with certainty, some factors tended to act primarily as barriers or facilitators—for example, university academic promotional systems were largely seen as barriers—in most cases it was the contextual information (personal, institutional or sectorial) which determined whether factors inhibited or assisted in diffusion or adoption of CFL.

(McNaught et al., 2000, p. 73)

The McNaught study also found that perceptions of the extent or degree of take-up of CFL varied and were related to the participant’s primary focus on either quantitative or qualitative measures of up-take. Thus, a quantitative view looked at numbers of staff using CFL in their teaching, or the number of students accessing online forums, while a more qualitative perspective was concerned about improvement in qualitative indicators, such as whether evaluation had shown improved learning outcomes (McNaught et al., 2000, p. 73). A difference between the levels of uptake reported by executives or senior managers and innovators more involved with project work was noted.

6.4.4 Difficulties with current diffusion research in higher education

In order to understand the process of diffusion, the specific higher education settings and the perceptions, expectations and skills of different potential adopters must be considered. A simple categorisation of individuals as ‘early adopters’ or ‘laggards’, however, is similar to labelling students as ‘deep’ or ‘surface’ learners. Individuals are likely to choose an approach to teaching and the use of new technologies based on their varied perceptions of their situations, as discussed in Section 5.4.

Putting this point aside for the moment, existing empirical evidence in the higher education literature on the characteristics of adopter characteristics is far from substantial. Many studies focus on the broad identification of incentives and barriers to adoption derived from surveys of staff (e.g. Beggs, 2000; Jacobsen, 2000a; Surry & Ensminger, 2002). Others attempting to distinguish between different categories of adopters are difficult to interpret for a number of reasons.

Different studies adopt different interpretations of innovativeness. For example, in the McNaught study, the Roger’s ‘early adopter’ and ‘early majority’ are combined into a significantly larger ‘earlier adopter’ category, with individuals surveyed asked to self-assess their position in relation to ‘their use of technology on teaching and learning’ (McNaught et al., 2000, p. 244). In contrast, a survey of faculty members of the University of Alberta employed Roger’s original terminology, but used a self-assessment of eight specific technological skills, rather than adoption behaviour (Anderson et al., 1998, p. 79). Differences in skill use between discipline areas were ignored. Another study of 76 faculty members across disciplines at two North American universities asked participants to indicate the year they first adopted 44 types of computer software and tools (Jacobsen, 2000b). Although this brings in the element of time, it is not stated how the adopter categorisation was made and it was also assumed that the technologies were equally relevant.
Another common problem relates to sampling, in particular, capturing the voices of more mainstream staff. It is also easier for investigators to target those already interested through existing professional groups (McNaught et al., 2000, p. 8) or individuals who have already subscribed to an educational technology list server (Jacobsen, 2000b).

The generalised lists of barriers, incentives and adopter categories from such broad surveys do little to clarify the relative importance of specific factors and the emerging issues within specific settings, to guide practice and policy. More targeted studies can explore factors at a level of contextual detail that, while not broadly generalisable, illustrate the complexity and human scale of innovation (Cleary, 1999). For example, one teacher after two years of being an ‘early adopter’, returned to more mainstream activities of research and publishing. By some definitions a ‘laggard’, they actually played a critical role as ‘opinion leader’, passing on an established initiative and providing ‘considered, cautious evaluation’ to the following adopters. That is, individual approaches will depend on the given circumstances and may change from case to case and over time, influenced, for example, by stress and the relationship between teachers and support staff. There are few published case studies revealing this level of detail.

6.4.5 The chasm between earlier and later adopters

Geoghegan has extended the general diffusion model to consider more critically the roles of higher education stakeholders (Geoghegan, 1994). Innovators in higher education are defined as experimentalists who latch on to new technology as soon as it appears and are probably more interested in this than its application to significant problems. They are a significant resource for technology vendors who need to test a product and are often broadly connected, forming interest groups spanning both disciplines and institutions. Early adopters are characterised by an interest in exploring new technologies for their potential to bring about major improvements in teaching through qualitative, discontinuous change. They are broadly connected with the academic community, innovators and support networks, are risk takers and often quite self-sufficient in technology skills. The early majority are pragmatists who, although comfortable with technology, are focused on the immediate tasks of teaching. They need compelling evidence and concrete local examples of the benefits of new teaching approaches before adopting, are less interested in major changes and are more risk adverse than early adopters. Their networks are more vertical, within the local discipline area. The late majority are the more conservative half of the mainstream teachers, sceptical of change, waiting until an innovation has become well entrenched before following. They prefer teaching technologies to be complete, ready-to-run solutions. The laggards are most likely never to adopt new instructional technology at all and may be antagonistic to its use by others.

The educational change literature is inclined to see the grassroots innovators as the key to more widespread institutional change, as their innovations spread by word of mouth and demonstration to later adopters in the institution (Johnston, 2001). The diffusion process, however, appears to reach a point of saturation in the adoption of instructional technologies by early adopters (Geoghegan, 1994).

The overwhelming evidence is that the development of more flexible learning environments through the use of [ICT] has been energised and primarily enacted by ‘lone rangers’ – individual staff members who are energetic, early adopters of innovation, and who are motivated by a desire to improve the accessibility and quality of their teaching.
While the role and efforts of innovators and early adopters are important aspects of educational change, other strategies are necessary to move from what might be considered their ‘cottage industry’, to more mainstream implementation and institutionalisation (Johnston, 2001; P. G. Taylor, 1998, p. 273). A number of higher education studies, for example, draw attention to a gap or ‘chasm’ between earlier and later adopters as a major reason for failure in the diffusion of new technologies (Anderson et al., 1998; Geoghegan, 1994; Jacobsen, 2000a; Johnston, 2001; Jones, Stewart & Power, 1999; P. G. Taylor, 1998). It is suggested that there are important cultural differences between these two groups summarised in Table 6.2, indicating that completely different approaches to fostering innovation may be required. That is, different arguments, incentives and modes of support are required if we are to move from a focus on only the 15% early adopter population (Geoghegan, 1994).

Table 6.2 Cultural differences between early adopters and the early majority

<table>
<thead>
<tr>
<th>Early adopter</th>
<th>Early majority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Favour revolutionary change</td>
<td>Favour evolutionary change</td>
</tr>
<tr>
<td>Visionary</td>
<td>Pragmatic</td>
</tr>
<tr>
<td>Project-oriented</td>
<td>Process-oriented</td>
</tr>
<tr>
<td>Risk takers</td>
<td>Risk adverse</td>
</tr>
<tr>
<td>Willing to experiment</td>
<td>Want proven applications</td>
</tr>
<tr>
<td>Generally self-sufficient</td>
<td>May need significant support</td>
</tr>
<tr>
<td>Horizontally connected</td>
<td>Vertically connected</td>
</tr>
</tbody>
</table>

(after Geoghegan, 1994)

Geoghegan lists a number of reasons behind the inability of innovators to move an innovation past this early market (Geoghegan, 1994):

1. **Ignorance of the gap between early adopters and early majority**
   
The failure to recognise qualitatively different subgroups leads to an assumption that some faculty staff simply have more ‘resistance’ than others and require stronger arguments, larger incentives and more support; rather than different arguments, different incentives and different modes of support.

2. **The technologist’s alliance**
   
   An alliance between ‘technologist’ populations, including faculty innovators and early adopters, campus IT support units and instructional technology vendors, has created a very strong community with common language, interests, level of comfort and support network. While this may have demonstrated the benefits technology can bring to learning and teaching, it is presented in a form well suited to the early market, but largely antithetical to the needs of the majority.

3. **Alienation of the mainstream**
   
   The high visibility projects of the early adopters have been inclined to capitalise on educational improvement funds and the nature of these projects has created what might be perceived by mainstream staff as unreasonably high expectations that they may be unable to meet. Mainstream staff may also find themselves left with responsibility for the innovator’s project after the developer has moved on to other things.
4. Lack of a compelling reason to adopt

While innovators and early adopters are driven by vision and willingness to take risks, later adopters must perceive a compelling value in pragmatic, mainstream terms, substantially in excess of the costs of adoption. The application needs to be one that “performs an existing important task, or solves an existing problem in a markedly better way; or it will be one that enables something new to be done in a way that contributes significantly to instructional effectiveness.” (Geoghegan, 1994).

Reliance on innovation processes alone will not lead to the desired cultural changes and institutions must respond to these demands with strategies that are themselves innovations. Academic managers and ‘change agents’ must simultaneously deal with the processes of innovation and appropriation for the mutual benefit of staff (P. G. Taylor, 1998, p. 277). If we are to capitalise on the significant amount of experimentation that has been fostered, we need methodologies to connect the decisions of individuals within their particular contexts to a supporting infrastructure that will encourage the organisation to learn.

6.5 A relational model for learning, teaching and support

The relational model of learning and teaching discussed in Section 4.5.2 revealed the critical link between a student’s perception of their situation and their adoption of a deep or surface approach to learning. For example, if a learning task is not perceived as relevant to a student’s needs at a particular time, that student is likely to adopt a surface approach to the task (Figure 5.4, p. 56). This relationship was extended to the situation of the teacher, whose approach to teaching is influenced by their perceptions of the workplace situation. For example, a teacher perceiving time pressure with little reward for effort, is likely to adopt a ‘teacher-centred’ rather than ‘student-centred’ approach to teaching or attempts to innovate. To affect learning outcomes, the teacher must identify and address the perceptions of students, to shape in a useful manner the student’s learning situation.

Many of the same negotiated dynamics occurring between teachers and students also occur between designers and teachers (Wilson, 1997, p. 16). We might postulate therefore that the organisational scope of the model can be extended to various forms of support for teachers. The relational model of university learning, teaching and support in Figure 6.9 inter-relates the situations and activities of the main stakeholders connected with teaching innovation. Such support roles in the right hand column might include academic leadership (Ramsden, 1998a), staff developers, IT support staff, educational designers, programmers, course coordinators or departmental heads; however, my focus in this study is primarily on CFL developers, who provide CFL materials or systems of potential use by teachers. The implications of this model are that staff with the responsibility of supporting teachers should seek to understand the varied teachers’ perceptions of their situation in order to adapt their approach to shape the teacher’s situation in a manner that increases the likelihood of success of the innovation. This core dialogue can be extended to other levels and roles to represent to many parallel interactions that might occur within specific institutional settings.
Although this extension of the relational model is not directly based on empirical studies of the perceptions of developers, it reflects themes of context, individual perceptions and conversational structures that have emerged in the organisational models examined in this chapter. For example, the model reflects a process of reflection and understanding and individual perspectives underpinning the collegial spirit of the entrepreneurial university (Section 6.2). It emphasises critical reflection at the level of individual learning as the foundations of organisational learning (Section 6.3.1) and the iterative adaptation and reflection process occurring at different levels of the organisation in the Conversational Framework (Section 6.3.2).

From a viewpoint of innovative development, the model stresses the need for developers to understand the varied perceptions and characteristics of users and the context of use, which will influence the likelihood and manner of adoption (Section 6.4). It means, for example, that use of the innovations depends not simply on the ‘quality’ of the initiative, but also the context in which it is applied and the characteristics and perceptions of the user. The understanding of the range in these perceptions will reveal the differences between the early and later adopters, with the associated requirement to use different approaches. The implications for teaching and development are that students and teachers need to be actively drawn into the process of teaching and development, that is, questions of use and adoption are beginning to merge with the design process.

I have found this model particularly useful in framing discussions with teaching support staff about approaches to teaching, CFL development and professional development. In particular, it emphasises the critical need to understand the ‘real’ needs and perceptions of teachers of their situation from the very start, before commencing
a development. If these perceptions are genuinely addressed, it can lead to fundamental re-conceptions of approach to CFL development. For example, time pressure is an important factor for teachers, therefore CFL and professional support systems that are recognised as time-saving by users are more likely to be adopted. This model also challenges the ‘technologist’s alliance’ that tends to develop between developers and the small population of faculty innovators, by emphasising the need to address the varied requirements of users revealed through the interpretation of the full range of individual perceptions of their situation.

6.6 Summary

This chapter has examined a number of views of the organisational context in which CFL development and innovation is located. Profound changes in universities are occurring, as traditional collegial culture become inadequate to deal with an increasingly complex global educational environment. Depending on their resources and history, universities are responding with new organisational models that may be bureaucratic, corporate or enterprise-driven. The enterprise or entrepreneurial university approach attempts to improve responsiveness by re-kindling the academic collegial spirit within a streamlined core management structure, supported by ‘benign’ ICT systems.

Organisations are defined by individuals who make decisions and act according to the assumptions implicit in their personal theories of action, as distinct from the ‘espoused’ theories used to justify and explain actions to others. Learning occurs when personal theories are adjusted in the light of feedback and is most significant in ‘double-loop learning’, when underlying principles and assumptions are questioned and revised through debate and critical reflection. Such individual learning underpins organisational learning and institutions need to actively create conditions to encourage double-loop learning. The organisation itself ‘espouses’ certain theories of action in the form of strategic plans and policy statements, although less formal theories-in-use drive the complex system of communications, assumptions and values that influence the actions of individuals.

Central to the traditional university structure is the student-teacher ‘conversation’ in which teachers identify, reflect on and respond to students’ learning needs. For the organisation itself to ‘learn’, such a process of analysis and knowledge generation needs to be iteratively repeated across different levels, so that information flows between individual teachers, tutors, course teams, educational designers, faculty groups and university committees. That is, the requisite structure for adaptive organisational learning requires that, for every level of practice, another level of discourse exists through which the articulated knowledge can be generalised and incorporated into supporting and management activities. At every level of the university, innovation and critical reflection underpins the wider sharing and implementation of learning approaches and organisational processes. It is this research-orientated activity that gives the university its competitive advantage.

Studies have shown how innovations are adopted to differing degrees by individuals within an organisation, who may be categorised as early adopters, early majority, late majority and laggards. Innovators, in particular, are driven by interest, are accepting of risk and change, can deal in abstractions and are more likely to relate to people outside the local group, compared with early adopters who are more integrated into the community. Members of the target population will perceive the desirability of an innovation differently so that multiple approaches to motivation and support are required. Moreover, an innovation may be ‘re-invented’ by the user
and go through several stages in the process of adoption and implementation. Adoption needs to be recognised as a complex process of social construction and with longer-term impacts.

There is little evidence of the adoption and diffusion of CFL developments within universities, despite national and institutional encouragement. While certain factors, such as culture, institutional policy, support and ownership, are related to the success of adoption, how these apply depends greatly on the context of the setting. In addition, perceptions of the degree of adoption vary according to the individual’s perspective, which may focus on qualitative or quantitative measures, or role in the process. CFL diffusion studies often place undue emphasis on technology, rather than educational innovativeness and focus on early adopters, rather than mainstream users. A ‘chasm’ is identified between early and later adopters, representing important cultural differences that require different approaches to foster uptake of the innovation. Few studies examine the localised contextualised information necessary to usefully describe the barriers to adoption and varied perceptions of individuals within particular settings.

The organisational perspective of this chapter is summarised in a relational model of learning, teaching and support that extends from the learning and teaching model of the previous chapter. This three level representation of the core dialogue between students, teachers and support staff, such as CFL developers, emphasises individual reflection, perceptions of individuals to their situation and variation in their approach. The model forms a useful framework for considering the development and diffusion of CFL innovations within a social structure that fosters recognition of workplace factors and the different requirements of users.

This chapter completes the conceptual overview of existing research literature relevant to the CFL Systems Development field as defined for the study in Chapter 3. The multiple perspectives on learning, educational design and development and the organisation discussed in the last three chapters will inform the research design in the Chapters 7 and 8, and provide a framework for drawing conclusions in Chapter 14.
CHAPTER 7. Methodology

Review of literature
3.2-3 Definition of the field of inquiry: CFL Systems Development

Perspectives on the literature:

Methodology
7.2-3 Research methodology

7.4 Action research
7.5 Grounded theory
7.6 Eclectic mixed-methods paradigm

Research methods & data

8.2 Production approach
8.3 Grounded analysis methods
8.4 Mixed methods

Figure 7.1 Contribution of Chapter 7 (bold) within the thesis structure of Figure 2.2

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7.1 Introduction

This chapter outlines the research methodology of the study and particular models of inquiry associated with the three inquiry goals (Figure 7.1). The specific research methods and tools used in the analysis will be discussed in chapter 8.

The structure of the epistemological argument I have constructed is summarised in Figure 7.2, which outlines the terminology, relationship between inquiry elements and particular assumptions adopted in the study.
Figure 7.2 Methodological terminology and structure adopted in the study

Figure 7.2 indicates how the foundations of any study will be grounded in the researcher’s fundamental philosophical worldview. Such a worldview underpins a paradigm within which the broad assumptions and principles of inquiry can be framed, while models of research provide key frameworks for the negotiation of standards and approaches within various communities. In practice, there is a continuous evolution within inquiry models and paradigms as they are negotiated and debated within communities. Specific tools and methods of research applied by researchers reflect the assumptions of different inquiry models or paradigms. It is worth emphasising, however, that espoused philosophical approaches may be inconsistent with a research design. Tools and methods are not inherently linked to a particular philosophical position; it is the contextual framework within which they are applied that shapes the alignment and consistency of an inquiry.

The model outlined in Figure 7.2 is only one possible representation of the methodological considerations of an inquiry, that is, how the research design can be approached. There is, of course, much overlap and multiplicity in interpretations of such a conceptual structure. For example, the use of the term ‘paradigm’ varies widely in its scope. I have distinguished here between broader inquiry paradigms and more specific discipline-focused models for research; however, in references to the literature, I have had to accommodate some variations in interpretation.

7.2 Philosophical assumptions underpinning the research design of the inquiry

The overarching philosophical stance of this study reflects a constructivist worldview. At different points in the literature review, I compared constructivist worldviews with alternative ‘traditional’ approaches, to emphasise the significance of this critical assumption (Sections 4.2, 4.3 and 5.2). The constructivist assumption is that meaning about the world is constructed by individuals, rather than existing as external knowledge independent of any individual. There is no single correct meaning or perspective for any event or concept (Duffy & Cunningham, 1996, p. 3), with multiple meanings constructed through social interaction within overlapping
communities. Specifically, it is my contention that workplace and research decisions about the development of CFL systems should acknowledge the existence and contributions of multiple perspectives of stakeholders acting within complex social settings.

The foundations of the inquiry established over the preceding chapters will influence the requirements of the research design considered in this chapter. Table 7.1 summarises the main assumptions.

**Table 7.1  Philosophical assumptions underpinning the research design of the inquiry**

<table>
<thead>
<tr>
<th>Assumption</th>
<th>Research requirement</th>
<th>Reference</th>
</tr>
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<tbody>
<tr>
<td>An authentic setting</td>
<td>Complexity of the workplace research setting from a national, institutional and personal perspective, exemplified by the pragmatic, open-ended formative questions raised.</td>
<td>Chapter 1</td>
</tr>
<tr>
<td>Multiple development goals</td>
<td>Strategic and interrelated goals of the research aimed at solving particular real world problems, while simultaneously establishing generalised models to guide future action.</td>
<td>Chapter 2</td>
</tr>
<tr>
<td>Multiple disciplines</td>
<td>The research field of ‘CFL Systems Development’ as one drawing on the assumptions, methodologies and techniques of diverse communities of stakeholders.</td>
<td>Chapter 3</td>
</tr>
<tr>
<td>Multiple perspectives</td>
<td>A multi-perspective framework for the research from different viewpoints in the literature, focusing broadly on learning, development and the organisation.</td>
<td>Chapters 4, 5, 6</td>
</tr>
</tbody>
</table>

Some form of principled framework, or paradigm, congruent with the inquiry purposes is required from which to guide the inquiry approach and locate it within relevant community discourse (Section 7.2.1). To this end, I have drawn on Reeves’ taxonomy of established and emerging research paradigms and inquiry models in Section 7.2.2. Given my choice to treat learning, development and organisational action as complex and ‘problematic’ social phenomena (Sections 4.1, 5.1, 6.1), I have argued in Section 7.3 that a pragmatic Mixed-Methods paradigm is most appropriate for this inquiry. From this broad paradigmatic position, more specific inquiry models relating specifically to the three goals of the study are adopted in Sections 7.4, 7.5 and 7.6.

**7.2.1 Inquiry paradigms**

Paradigms, in the form of clearly delineated and well-established models of inquiry, inform the actions and discussions of participant and researchers within particular fields (Dills & Romoszowski, 1997b, pp. 9-10; Reeves, 1997, p. 163). They are found, for example, in instructional development (Dills & Romoszowski, 1997b, p. 5), evaluation (Phillips et al., 2000, p. 1.4; Reeves, 1997, p. 163) and organisational management (Senge, 1992). Paradigms evolve as a given field develops and anomalies revealed require reconceptualisation. At times entirely new paradigms may emerge, creating major upheaval within a community. The shift from Newtonian to Quantum physics, for example, caused major changes in the philosophy, research methodology and analytical methods within the scientific field. Similarly, the movement from the ‘objectivist’ to ‘constructivist’ paradigm has led to radical changes in the process of education, changing the roles of student and teacher (Dills & Romoszowski, 1997b, p. xii).

Kuhn suggests that approaches to inquiry in the social sciences are ‘pre-paradigmatic’ (Kuhn 1962 in Reeves, 1997, p. 164). That is, consensus has not been reached on the fundamental assumptions and methodologies appropriate to studying the complexities of human behaviour. Similarly, the boundaries of the field of educational technology are still undefined, let alone the ways to think within them (Saettler 1990 in Dills & Romoszowski, 1997a, p. 18). Multiple competing paradigms are associated with multiple sources of theoretical
foundation, employment structures, philosophies and technologies supporting the field at a given time (Dills & Romoszowski, 1997a, pp. 16 -17). Reeves describes the problem facing instructional designers:

On the one hand, the lack of a dominant evaluation paradigm leaves instructional designers with insufficient guidance for conducting evaluation within the context of instructional design. On the other hand, having competing evaluation paradigms from which to choose provides them with insufficient direction for applying one or more specific evaluation models to support instructional design activities.

(Reeves, 1997, p. 164)

In addition, the domination of current thinking by certain paradigms can be counter-productive to the creativity that underlies authentic inquiry (Reeves, 1997, p. 164).

Methodologies in emergent fields, such as educational technology research, are immature and underpinned by a collection of contested perspectives, indicative of the mixed background of participants and the pace of change occurring within both education and technology (Section 5.2).

### 7.2.2 A framework for educational inquiry paradigms

Reeves’ framework of evaluation paradigms for instructional design outlines the strengths and weakness of different approaches that might be adopted in the research design of this study (Reeves, 1997, p. 165). Although the framework focuses on evaluation, the processes of evaluation and research of the type undertaken in this study are closely related. Formative evaluation, in particular, involves the collection and interpretation of information during the development process, specifically to inform the design process.

The three established paradigms that represent the major investigative approaches to educational inquiry are positivist, interpretivist and critical theory. In the light of controversy regarding the variation across these approaches and the observation that many educators resist being categorised as any one of them, Reeves proposes a fourth paradigm, which he describes as the “eclectic” or “mixed-modes” paradigm (Phillips et al., 2000, p. 1.5; Reeves, 1997, p. 165).

**The Analytic-Empirical-Positivist-Quantitative Paradigm** is the most established of the paradigms that have guided evaluation. Such ‘scientific’ studies are characterised by the use of quasi-experimental methods, control groups, control of variables and investigator objectivity. They are concerned with the gap between stated objectives and learning outcomes, for example, to establish that one CFL approach is more effective than another.

Such studies have been criticised on the grounds that it is difficult to set up controlled conditions, they are possibly unethical and the tests themselves may be unrepresentative of important learning outcomes (Reeves, 1997, p. 167). Most significantly, these investigations are primarily concerned with proving or disproving an hypothesis, not how a phenomenon occurred. Their application within this study is limited by the compromised ‘authenticity’ of their settings.
The Constructivist-Hermeneutic-Interpretivist-Qualitative Paradigm offers an alternative approach for investigating complex social processes, without resorting to a single viewpoint or mathematical model (Reeves, 1997, p. 168). Such investigations focus on the context of the setting and acknowledge the multiple perspectives of stakeholders. The constructivist orientation reflects the belief that knowledge is constructed by the individual and is socially negotiated (Guba & Lincoln, 1989, p. 13). The interpretivist nature of this paradigm means that such approaches are concerned with human observation and qualitative methods. They recognise that the investigator is bound up in the situation, rather than being a detached, objective observer. This paradigm is pertinent to evaluation and instructional development studies seeking rich information to inform decision-making.

Interpretivist studies have been criticised for producing findings that are too subjective, lacking in generalisability or being too difficult to produce (Reeves, 1997, p. 169). For example, evaluation outcomes are seen primarily as an agenda for negotiation by the stakeholders, rather than absolute conclusions, recommendations or value judgements produced in conventional forms of evaluation (Guba & Lincoln, 1989, p. 13).

The Critical Theory-Neomarxist-Postmodern-Praxis Paradigm emerged as an alternative to the reductionist view of the positivist paradigm and the subjective views of interpretivist paradigms and is focused on action, rather than analytical modelling or description (Reeves, 1997, pp. 170-1). Critical theory contends that power and oppression are the fundamental concerns of inquiry in social settings. Within instructional development, critical theory encourages developers to question the cultural, political and gender assumptions behind an educational project. Proponents would see hidden agendas behind instructional technology and education reforms, which can be revealed through criticism or deconstruction of texts. Participants in a setting are central to the inquiry and improvement is generated through reflective work practice.

The Eclectic-Mixed Methods-Pragmatic Paradigm was proposed by Reeves as a practical way of dealing with the complexity involved in instructional development, and in contemporary society and technology in general (Reeves, 1997, p. 173). The approach here is to ‘borrow’ methods of the other paradigms to collect information and solve a problem. Viewed as tools, paradigms are meaningful only within the context of their use and one approach is not necessarily preferable to another when it comes to particular problem-solving requirements.

Paradigms and models are only tools, and as such, should be selected only after the purpose or question of the evaluation is understood. Some questions are certainly more susceptible to quantitative, positivist methods, others to a qualitative methodology, and still others may cry out for the skeptical analysis that only a critical theory approach can provide. More likely, multiple methods will be appropriate to “triangulate” or “bracket” the phenomena and provide a more balanced perspective.

(Reeves, 1997, p. 176)

While the mixed method may be more complex to apply than a single approach, the benefits will be a more realistic portrayal of events. While the apparent opportunism in selecting methods in this way might imply a lack of rigour, the need for well designed and implemented strategies that apply in any study are equally relevant. The
paradigm has been recommended as an approach to evaluation of CFL projects, emphasising that both quantitative and qualitative information can be uncovered (Phillips et al., 2000, p. 1.5).

7.3 The research methodology of this study

Reeves’ Eclectic-Mixed Methods-Pragmatic Paradigm described above provides a philosophical foundation for the research design of this study to address the practical ‘development’ goals developed in Section 2.3:

…research and evaluation efforts should primarily be developmental in nature, i.e., focused on the invention and improvement of creative approaches to enhancing human communication, learning, and performance through the use of interactive learning technologies. The purpose of such inquiry should be to improve, not to prove. Further, developmental research and evaluation should not be limited to any one methodology. Any approach, quantitative, qualitative, critical, and/or mixed methods, is legitimate as long as the goal is to enhance education.

(Reeves, 1999, p. 18)

Within this paradigm, which I will abbreviate to the Mixed-Methods Paradigm, various research models can be judiciously selected as ‘tools’ to improve understanding and solve the practical problem at hand (Reeves, 1997, p. 173). Either quantitative or qualitative forms of inquiry may be chosen to expose particular aspects of the phenomena and, by remaining open to the use of multiple paradigms, a more realistic ‘bracketed’ portrayal of complex phenomenon can be obtained. The difference is noted here between ‘bracketing’, which uses alternative data gathering methods to add richness to an investigation, and ‘triangulation’, which implies that a convergence on a more precise assessment is intended (Reeves, 1997, p. 175). The concept of bracketing is therefore more in line with the philosophy behind the Mixed-Methods Paradigm and I will use this term in favour of ‘triangulation’ within the study.

A pragmatic approach is necessary to deal with the complexity of the setting, for example, to articulate the assumptions, theories, methods and findings of an inquiry in a form accessible to stakeholders through plain English descriptions. Although recognised as problematic, the Mixed-Methods Paradigm seeks to influence outcomes more than would “politics, ignorance, intuition, habit and prejudice” alone (Reeves, 1997, p. 174).

Table 7.2 summarises the core assumptions of the Mixed-Methods Paradigm (Reeves, 1997, p. 173). These are congruent with the philosophical assumptions of the inquiry outlined in Table 7.1 and stress the need to consider the authentic setting, multiple development goals, multiple disciplines and multiple perspectives that characterise the purpose and setting of the study. The paradigm deliberately moves away from assuming an ‘expert’ interpretation of the situation and adherence to a single established paradigm or discipline, such as instructional development or software engineering. The problems under investigation are recognised as being complex, context dependent and involving different professional agendas and perspectives. Likewise, the outcomes of such research are seen as strategies for practical action rather than grand theories, although the strength of the open and multi-perspective inquiry will reveal meanings that can be usefully considered in other contexts.
In the following sections, I will examine the various models of inquiry adopted for each of the three goals of the study coming within the Mixed-Methods Paradigm.

### 7.4 Goal 1: developing a software system (action research)

The first goal of this study is to develop a generic software system to facilitate the implementation of innovative online learning environments across the University (Section 2.3.1). This is an ‘Action goal’ focusing specifically on the production of a useable product. The undertaking will require pragmatic decisions and value judgements of learning design, software technology, academic needs and organisation strategy. Further, the initiative emphasises the ‘leading edge’ application of emerging and often immature software and online technologies, which are untested both in their technical capacities and application to learning and teaching.

The most relevant general model of inquiry suiting the particular workplace situation outlined in Chapter 1 and open-ended nature of the technical undertaking is action research. This section outlines action research in general and forms emerging in the discipline of Information Systems, which are highly relevant to this study. The specific action research methods and tools used in the study are described in Section 8.3.

#### 7.4.1 Action research

Action research was first used as a means for investigating social issues by involving community members in fact-finding and decision-making processes (Carr & Kemmis, 1986, p. 164). Participants likely to be affected by planned changes actively learn about their situation as well as improve it, rather than relying solely on external ‘objective’ experts. Forms of action research have been applied to practical inquiry in many disciplines, including education (Kemmis & McTaggart, 1997, p. 1) and information systems planning and development (Lau, 1997).

Action research is typically depicted as a set of mainly qualitative approaches to manage complex situations in a critical and practical manner.
Action research is a form of collective self-reflective enquiry undertaken by participants in social situations in order to improve the rationality and justice of their own social or educational practices, as well as their understandings of these practices and the situations in which these practices are carried out. (Kemmis & McTaggart, 1997, p. 5)

A common theme of action research is the application of a cyclical and collaborative process of planning, action, observation and reflection in the context of some general concern or mission. The exact meaning and extent of activity varies according to the individual application and nature of the inquiry. For example, as a general strategy for institutional change, researchers may use local help to design a ‘field experiment’, with the data collected used to provide feedback to local ‘activists’ and to craft the next stage of operations (Miles & Huberman, 1994, p. 9). This may use naturalistic inquiry approaches, such as participant observation, descriptive data, holistic perspective, or discovery of underlying themes or patterns. In other studies, researchers more closely join with participants from the outset, to transform the social environment through a process of critical inquiry by ‘collaborative action research’. The methods here might be selected to unpack and tackle invisible but oppressive structures, emphasising the ‘emancipatory’ focus of the inquiry. ‘Emancipatory action research’ is aimed, not only at technical and practical improvement and the participant’s transformed consciousness, but also at changing the system itself and the conditions that impede desired improvement in the system (Zuber-Skerritt, 1996, pp. 84-5).

### 7.4.2 The Information Systems action research paradigm

I have focused in this study on forms of action research within the Information Systems discipline because of their relevance to organisation software systems development. Although Information Systems research methodology has been strongly influenced by positivist traditions (Falconer & Mackay, 1999, p. 289) in the same manner as instructional design and development (Section 5.2), there is a growing acceptance of qualitative and mixed research approaches. This is possibly associated with a shift away from technical to managerial and organisational issues (Falconer & Mackay, 1999, p. 290; Garcia & Quek, 1997, pp. 447-8; Lee et al., 1997 287, p. 3; Markus, 1997, p. 12; Mingers, 2001 262, p. 240). This emerging community in Information Systems is conscious of ‘borrowing’ research models and methods from other disciplines as a means of introducing important innovations to the field (Garcia & Quek, 1997, p. 446). Mindful of the need for a sound methodological framework, this openness to new ideas, incorporation of structures from multiple disciplines and pragmatic attitude, aligns with the philosophy of the Mixed-Methods Paradigm of Section 7.3.

Action research is particularly suited to the applied nature of the Information Systems field (Avison, Lau, Myers & Nielsen, 1999; Lau, 1997, pp. 31-32), as well as to the project-based orientation of this study. Overviews of Information Systems action research studies reveal many possible interpretations of emphasis and approach (Baskerville & Wood-Harper, 1998, pp. 94-100; Lau, 1997, pp. 34-5). The activities reported vary widely from consultancy work that may ‘falsely’ claim to be action research, to approaches such as Information Systems Prototyping that may fall within the action research definition but is not acknowledged as such (Baskerville & Wood-Harper, 1998, p. 91). Baskerville and Wood-Harper argue for a more useful definition of Information Systems action research based on core characteristics of the process, rather than the generalised form of action research often articulated in studies (Baskerville & Wood-Harper, 1998, p. 106). Under this definition, a study
falling within the action research definition has the following characteristics (Baskerville & Wood-Harper, 1998, pp. 91-2):

- it is set within a complex, multivariate social setting;
- observations are made and analysed within an interpretive manner;
- there is action by the researcher to intervene in the problem situation;
- data collection includes participatory observation; and
- the research involves study of change in the social setting.

A cyclical process is not considered a necessary requirement of all action-based research approaches, for example, professional consultancy may explicitly plan for only a single iteration to reach a conclusion (Baskerville & Wood-Harper, 1998, p. 107).

The iterative ‘canonical’ form of action research shown in Figure 7.3 has been widely used to promote understanding of Information Systems development (Susman 1983 in Baskerville & Wood-Harper, 1998, pp. 96-7; Kock et al., 1997). Five phases of an iterative process are represented within a client-system infrastructure supporting collaborative agreement and dissemination of knowledge.


In the first phase of the canonical form of action research (Figure 7.3), diagnosing involves the identification of primary problems, which are interpreted holistically, rather than through reduction and simplification. Researchers and practitioners collaborate in planning the target and approach to change, guided by some theoretical framework. After the actions are completed, outcomes are evaluated collaboratively and reasons for success or otherwise are questioned. Where unsuccessful, a framework for the next iteration of the cycle is established, which may include revision of the theory.

Specifying learning is usually an ongoing process in which knowledge gained is disseminated in three possible forms. Firstly, organisational norms may be restructured through ‘double-loop learning’ to reflect the knowledge gained by the organisation during the research. Secondly, knowledge gained from unsuccessful interventions will inform the diagnosis process for the next iteration of the research cycle. Finally, knowledge is provided for the scientific community for dealing with future problem settings. The strengthening of findings and expansion of research scope through multiple iterations is seen as a major benefit of the action research cycle (Kock, McQueen & Scott, 1997, Section 7).
The literature on Information Systems action research aligns with the project production focus of this study and the associated CFL Systems Development field defined in Chapter 3, as summarised in Table 7.3.

Table 7.3  Parallels between Information Systems action research and this study

<table>
<thead>
<tr>
<th>Characteristic of Information Systems field</th>
<th>Source</th>
<th>Relevance to this study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parallel client and research knowledge interests.</td>
<td>(Kock, 2001; McKay &amp; Marshall, 2001, p. 46)</td>
<td>Draws heavily on individual funded curriculum projects of teachers, underpinning my simultaneous development of a broader generic CFL system.</td>
</tr>
<tr>
<td>A focus on organisational software system development.</td>
<td>(Chiasson &amp; Dexter, 2001, p. 93; Mumford, 2001, p. 12)</td>
<td>The generic CFL online system will be employed across all disciplines of the university and run centrally.</td>
</tr>
<tr>
<td>Varying models of relationship between the systems analyst/consultant/researcher and client in the organisation.</td>
<td>(Baskerville &amp; Wood-Harper, 1998, p. 95; Israel, Schurman &amp; Hugentobler, 1992, p. 74)</td>
<td>My role varies across projects and time, from educational consultant serving academic 'clients', development team member, to collaborator on joint projects.</td>
</tr>
<tr>
<td>Varying degrees of project formalisation and control.</td>
<td>(Avison, Baskerville &amp; Myers, 2001; Israel et al., 1992, p. 87)</td>
<td>Across the study, various formal agreements and responsibilities are evident in projects and workplace activities.</td>
</tr>
<tr>
<td>A young and evolving field adopting mixed approaches from other disciplines.</td>
<td>(Garcia &amp; Quek, 1997, p. 446, 448; Kock et al., 1997, p. 1; Lee et al., 1997, p. 3)</td>
<td>The online CFL Systems field is very young, evolving rapidly and involving individuals from different backgrounds.</td>
</tr>
</tbody>
</table>

The generic online system in this study may be viewed as an organisational ‘information system’, mediating communication between teachers and students. The Information Systems research perspective focuses not only on the ‘effectiveness’ of such systems, but also on understanding their impact on individuals, organisations and society at large (Garcia & Quek, 1997, pp. 450-1). Broadening the inquiry context in this manner acknowledges the complexity of the ‘authentic setting’ and ‘multiple perspectives’ reflected in the inquiry (Section 7.2) and Mixed-Methods Paradigm (Section 7.3).

7.4.3 Variation in Information Systems action research approaches

The above generalised action research (AR) model is a starting point for considering research design; however, it offers limited guidance when the true complexity of real settings and inquiries are considered.

These difficulties are compounded by the fact that AR is highly situational. Each AR project, to some extent at least, is unique, and it is difficult to draft general laws about how to carry out such projects.

(Avison et al., 2001, p. 29)

The gap between the model rhetoric and the reality of the workplace might be reduced by exploring the variation in philosophical approaches within the model. While the general desirability of a ‘mutually acceptable ethical framework’ may be a key to action research, this appears “somewhat naïve” in the real world situation, where “either the practitioners or researchers have the upper hand in most control aspects, in particular, initiation and determination of authority” (Avison et al., 2001, p. 42). The same issue is raised in Section 5.2.2 as the gap between instructional development paradigms and what instructional developers actually do. It is not an issue about choice of methods, but an expression of the philosophical rationale of the Mixed-Methods Paradigm, which emphasises an openness to rethinking a research approach, switching course in response to real situations. From this perspective, a pragmatic inquiry model must adequately allow for variations, not only between studies,
but also as cases proceed (Mumford, 2001, p. 19). Two possible frameworks for examining the characteristic forms of Information Systems action research are considered here.

Baskerville and Wood-Harper have categorised action research studies in the literature according to their process models, structures, researcher involvement and goals (Baskerville & Wood-Harper, 1998, p. 96). Their intention is to encourage recognition and acceptance of the diverse forms of Information Systems action research, so that the research methodology can be made more explicit and be applied to a broader range of studies.

Different forms of Information Systems action research reveal different combinations of inquiry approaches. For example, the ‘Canonical Form’ of action research discussed in Section 7.4.2 is associated with an iterative process model, rigorous structure, collaborative involvement and the dual goals of organisational development and improvement of scientific knowledge. On the other hand, ‘Action Science’, which builds on work by Argyris and Schön in organisational learning and reflective practice (Section 6.3.1), may share the same goals, but employs a more fluid reflective process model, aimed at building professional knowledge that is grounded in the reality of the workplace context (Baskerville & Wood-Harper, 1998, p. 100). ‘Clinical Fieldwork’ studies also share the dual organisational development and scientific knowledge goals, but are characterised by a linear process in which paid experts are brought in to help clients with an immediate problem.

Table 7.4 Process model classification of action research forms in Information Systems literature

<table>
<thead>
<tr>
<th>Research characteristic</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Process model</strong></td>
<td>Iterative</td>
<td>Entire set of research activities is repeated until the problem is resolved.</td>
</tr>
<tr>
<td></td>
<td>Reflective</td>
<td>Uses iteration, but focuses on revealing personal understanding of action taken, rather than primarily on the solution to a problem.</td>
</tr>
<tr>
<td></td>
<td>Linear</td>
<td>Expert consultancy interventions and field work in problem settings. Planned to reach a resolution, rather than continuing through iterative processes until a result is settled.</td>
</tr>
<tr>
<td><strong>Structure</strong></td>
<td>Rigorous</td>
<td>Rigorously defined stages or iterative sequences.</td>
</tr>
<tr>
<td></td>
<td>Fluid</td>
<td>Unpredictable unfolding of a study.</td>
</tr>
<tr>
<td><strong>Typical involvement</strong></td>
<td>Collaborative</td>
<td>Researcher is an equal co-worker with the study subjects.</td>
</tr>
<tr>
<td></td>
<td>Facilitative</td>
<td>Cooperative, with the subjects primarily responsible for solving the immediate problem and determining interventions, supported by expert advice or independent viewpoint of the researcher.</td>
</tr>
<tr>
<td></td>
<td>Expert</td>
<td>Responsibility for solving the immediate problem setting rests with the researcher.</td>
</tr>
<tr>
<td><strong>Primary goals</strong></td>
<td>Organisational development</td>
<td>Improving social conditions in the organisation, for example, morale, structural efficiency or information flows.</td>
</tr>
<tr>
<td></td>
<td>System design</td>
<td>Creation of structural artefacts behind organisational systems, usually computer-based information systems.</td>
</tr>
<tr>
<td></td>
<td>Scientific knowledge</td>
<td>Generalisable understanding of the problem setting, expressed within the literature of the field and necessary for practitioners to use the understanding in different settings.</td>
</tr>
<tr>
<td></td>
<td>Training</td>
<td>Individual learning and the understanding of particular problem settings by the individual researcher or group of participants undertaking the study.</td>
</tr>
</tbody>
</table>

While such a process-orientated classification of approach is useful, the practical reality is that the researcher may adopt different roles depending on the problem setting and phase of the project. Moreover, role-related tensions may arise in the course of action research related to:

- conflicting values, interests and timeframes;
- issues of project control, political realities of the setting; and/or
- an imbalance in the rewards and costs involved (Israel et al., 1992, p. 76).

The relationships between researchers and organisational members are also observed to be dynamic. It may be, for example, that ownership and control of a process are gradually transferred to employees. Israel et al conclude that, while role-related tensions between researchers and employees may arise, if individuals are engaged in a manner in which differences in perspective, knowledge and control are recognised and respected, these issues can be viewed as beneficial to the action research process (Israel et al., 1992, p. 97).

One possible way in which the rigor of action research can be improved is by focusing on the control structures for projects, that is, who initiates the project? where does the authority lie? and what is the degree of formalisation? (Figure 7.4). Negotiation of these factors is critical for our understanding of the action research method, extending the rigor of projects and increasing the likelihood of success (Avison et al., 2001, pp. 28-9).

Within the multiple discipline project environment of this study, responsibilities and relationships between teachers and developers will vary significantly in each case and impact on the research and development approach adopted, recognising also the possibility of change occurring over the life of a project.

Figure 7.4  Control characteristics of action research

<table>
<thead>
<tr>
<th>Control aspect</th>
<th>Forms</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Initiation</strong></td>
<td>Researcher</td>
<td>Field experiment.</td>
</tr>
<tr>
<td></td>
<td>Practitioner</td>
<td>Classic action research genesis.</td>
</tr>
<tr>
<td></td>
<td>Collaborative</td>
<td>Evolves from existing interaction.</td>
</tr>
<tr>
<td><strong>Authority</strong></td>
<td>Practitioner</td>
<td>Consultative action warrant.</td>
</tr>
<tr>
<td></td>
<td>Staged</td>
<td>Migration of power.</td>
</tr>
<tr>
<td></td>
<td>Identity</td>
<td>Practitioner and researcher are the same person.</td>
</tr>
<tr>
<td><strong>Formalisation</strong></td>
<td>Formal</td>
<td>Specific written contract or letter of agreement.</td>
</tr>
<tr>
<td></td>
<td>Informal</td>
<td>Broad, perhaps verbal, agreements.</td>
</tr>
<tr>
<td></td>
<td>Evolved</td>
<td>Informal or formal projects shift into the opposite form.</td>
</tr>
</tbody>
</table>

(after Avison et al., 2001, p. 38)

These control characteristics will be further developed to clarify the research approach methods in Section 8.3.

7.4.4 Information Systems Prototyping

‘Information Systems Prototyping’ is a highly relevant approach to systems analysis that, while not to sharing the same theoretical foundations, appears to come within the boundaries of action research (Baskerville & Wood-Harper, 1998, p. 98). It is categorised in the framework of Table 7.4 as an iterative process with a rigorous structure involving the researcher in a collaborative and facilitative engagement with participants, during which partially constructed versions of the software are developed and trialed.

Information Systems Prototyping would appear to be closely related to the process of Rapid Collaborative Prototyping discussed in Section 5.2.3. In both cases, the use of prototypes facilitates collaboration and
communication between researchers and users, which can “surmount the esoteric nature of system design
descriptions by presenting a working model of a specification, and allow the user to understand and comment on
the design” (Baskerville & Wood-Harper, 1998, p. 99). Prototypes may be employed to test preliminary design
ideas or initial specifications, or to provide a pre-finalisation test run of a traditionally developed system. They
may also evolve through iterative phases into the final system when full functionality has been achieved.

My approach to the software production goal of the study is informed by an action research model involving the
iterative development of prototype systems, within an ‘authentic’ educational setting. This is an ‘authentic
problem’ in which I have taken a holistic approach to a complex technical and educational design undertaking.
The inquiry approach is necessarily loosely structured, reflecting the necessary ‘openness’ to alter the approach
in response to changing technologies and in recognition of the leading edge nature of the inquiry. It also
critically depends on the input of ‘multiple perspectives’ drawn from different degrees of collaboration with
academic users and colleagues within individual projects. My own role is also likely to change between
educational designer, consultant, developer, programmer, evaluator and trainer.

Although the primary goal of this aspect of the study is a software systems development, this cannot be entirely
disconnected from the other study goals discussed below, which are concerned with understanding of the
development process and development of an organisational model for the workplace.

7.5 Goal 2: understanding the processes of development
   (grounded theory)

The second goal of this study introduced in Section 2.3.2 is to develop understanding of the CFL development
process, by reflecting on the workplace experience of the above software production. Given my philosophical
position in this study, I have adopted grounded theory as a practical model for investigating the complexity and
multiple perspectives that represent the real world of the workplace. The methodology of grounded theory is
discussed below, with the specific methods and tools used in the analysis described in Section 8.4.

7.5.1 Grounded theory

Grounded theory was proposed by Glaser and Strauss (1967), as a systematic research approach for discovering
theory from data, in contrast with social research approaches of the time that emphasised experimental validity,
hypothesis construction, objectivity and verification of theory (Glaser & Strauss, 1967, pp. 101-115; Strauss &
Corbin, 1998, p. 9). While primarily taken up in sociology and nursing, it is relevant to other areas for making
meaning out of political, educational, economic or industrial phenomena (Glaser & Strauss, 1967, pp. 101-115),
1171) and organisational research (Pandit, 1996).

Glaser and Strauss argued that too much emphasis had been placed on the logical deduction of theory from a
priori assumptions, thereby neglecting preceding stages in which concepts and hypotheses are first identified
from empirical observations. Grounded theories are not only generated from the data (rather than other theories),
but are systematically worked out in relation to the data during the process of research. In generating a grounded
theory, the researcher tries to approach the investigation with an open mind, allowing the theory to emerge from
the data, rather than from preconceived ideas. Of course, personal biases and understandings will always play a part; however, theory derived in this way is more likely to represent the real situation than one bringing together concepts based only on prior experience or merely speculation. As such, they are more likely to “offer insight, understanding and provide a meaningful guide to action” (Strauss & Corbin, 1998, p. 12).

In contrast to other methods, there is constant interplay between data collection and analysis. For example, an analysis of data will reveal unexpected effects that call for data collection to be undertaken in different areas. There is a critical difference between such ‘theoretical sampling’ and scientific ‘random sampling’, which seeks to distance the researcher from such influence in the inquiry process. Further, theory grounded in empirical data cannot be completely refuted by data in later studies or replaced by other theories, although it may be progressively modified in the light of new data. Ideas or models may come from sources outside the data, whether through flashes of insight, speculation or common sense, but must be brought into relation to the data, if they to relate to the empirical world (Glaser & Strauss, 1967, p. 6).

Generated theories must ‘fit’ the situation being researched, so that derived categories and dimensions must be readily indicated by the data and not ‘forced’. If they are to be useful, the theories must explain the situation under study and provide participants with useful interpretations, explanations and predictions with which to guide further work.

Thus theory in sociology is a strategy for handling data in research, providing modes of conceptualization for describing and explaining. The theories should provide clear enough categories and hypotheses so that crucial ones can be verified in present and future research; they must be clear enough to be readily operationalized in quantitative studies where appropriate. The theory must also be readily understandable to socialists of any viewpoint, to students and to significant laymen.

(Glaser & Strauss, 1967, p. 3)

While grounded theory is generally thought of as ‘qualitative’ methodology (Savenye & Robinson, 1996), both qualitative and quantitative approaches are useful in the generation and verification of theory, depending on the circumstances of the research and the interests and skills of the researcher. It has been criticised by traditionalists, however, for the way in which data collection and analyses are redirected as new issues emerge (see Section 7.7), and by postmodernists, for its privileging of the researcher and objectivist emphasis on method, the ‘reality’ of data and ‘verification’ of theory (Charmaz, 2000, pp. 523-4). There is also debate over what it is and what it should be, with conflicting positions developing between the original proponents and a continuum between the objectivist interpretation and later constructivist ideals (Charmaz, 2000, p. 510).

A constructivist interpretation of grounded theory recognises that categories and relationships emerge as a result of the researcher’s interaction with the data and inherent biases; they reflect what and how the researcher goes about collecting and shaping the data (Charmaz, 2000, pp. 522-3). While the grounded researcher should remain sensitive to multiple realities and viewpoints, the interpretation will incorporate the researcher’s own experience and portrayal of others’.
7.5.2 A grounded theory research model for this study

Grounded theory provides a research model that is congruent with the Mixed-Methods Paradigm discussed in Section 7.3. It provides a means of making sense of large quantity of data collected within the study, such as participant journals, communications, documents and software artefacts. Further, it is a pragmatic process that it remains open to emerging issues and events as they unfold over the course of the inquiry.

The key elements informing the research design in this study are based on the grounded theory model of Strauss and Corbin, involving three primary phases for managing the analysis: description, conceptual ordering and theorising (Strauss & Corbin, 1998, p. 15).

*Description* draws on ordinary vocabulary to convey ideas about situations, people or events (Strauss & Corbin, 1998, pp. 16-18). It involves a purpose, which might be to convince, persuade or arouse emotions with the target audience. Conscious or unconscious filtering of details by the storyteller shapes the intended message. Descriptions can form the basis of higher-level conceptual analysis of data, for example, within conceptual ordering or theorising. Descriptions are likely to already contain some degree organisation and categorisation, such as chronological ordering.

*Conceptual ordering* involves a more conscious organisation of data into discrete categories, according to their properties and dimensions (Strauss & Corbin, 1998, pp. 19-21). Categories are defined and clarified by descriptions of representative cases. This organisation of data forms an emerging framework with which phenomena can be differentiated and variation across a range can be illustrated. Conceptual ordering is a precursor to theorising.

*Theorising* involves conceiving and formulating ideas into a logical, systematic and explanatory scheme (Strauss & Corbin, 1998, pp. 21-24). These statements of relationships provide guidance to practice, enabling users to explain and predict events. Theories generated can be substantive, derived from an analysis of a single area, or formal, in which case relationships across a broad range of settings and conditions provide a more generalised view of action.

The characteristics of grounded research in relation to the requirements of the Mixed-Method Paradigm (Section 7.3) are summarised in Table 7.5, illustrating the relevance to the research design for analysis of the workplace experience.
Table 7.5 Contributions of grounded theory to the requirements of the study of workplace experience

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Contribution of grounded theory</th>
<th>Relevance to study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Authentic problems</td>
<td>• Making sense of masses of data reflecting complex social issues (Strauss &amp; Corbin, 1998, p. x).</td>
<td>• Educational, workplace, organisational, political and technical phenomena.</td>
</tr>
<tr>
<td></td>
<td>• Educational, workplace, organisational, political and technical phenomena.</td>
<td>• Extensive data over seven years.</td>
</tr>
<tr>
<td>Openness</td>
<td>• Acknowledges that researchers bring biases, prejudices and stereotypical perspectives, but are</td>
<td>• Sensitive to changing technical and educational directions.</td>
</tr>
<tr>
<td></td>
<td>open to criticism and debate (Strauss &amp; Corbin, 1998, p. x, p. 5).</td>
<td>• Adaptation to new project and collaboration situations.</td>
</tr>
<tr>
<td></td>
<td>• Theories remain modifiable and open to negotiation.</td>
<td></td>
</tr>
<tr>
<td>Multiple perspectives</td>
<td>• Requires a willingness to listen and ‘give voice’ to individuals or organisations (Strauss &amp; Corbin, 1998, p. 43).</td>
<td>• Uncovers connections with faculty teachers, colleagues and managers in evolving relationships and roles.</td>
</tr>
<tr>
<td></td>
<td>• Theories emerging from data more likely to represent understandings and language of participants.</td>
<td>• Produces findings for multiple audiences.</td>
</tr>
<tr>
<td></td>
<td>• Relevant to both lay and professional audiences (Strauss &amp; Corbin, 1998, p. 10).</td>
<td></td>
</tr>
<tr>
<td>Multiple disciplines</td>
<td>• Disciplinary literature can guide problem identification, provide sources of data for analysis,</td>
<td>• An inquiry approach that does not favour the approaches and values of any particular discipline interests (Section 3.3).</td>
</tr>
<tr>
<td></td>
<td>but constrain open interpretation of empirical data.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Not necessary or practical to review all the literature in the field beforehand, as it is</td>
<td></td>
</tr>
<tr>
<td></td>
<td>impossible to know which areas of investigation will emerge (Strauss &amp; Corbin, 1998, p. 49).</td>
<td></td>
</tr>
<tr>
<td>Pragmatism</td>
<td>• Research design emerges during the research process as understanding develops (Strauss &amp; Corbin, 1998, p. 33).</td>
<td>• Enables change of inquiry focus as emerging picture of the development experience is revealed.</td>
</tr>
<tr>
<td></td>
<td>• Techniques are applied flexibly and creatively, rather than in a rigid step-by-step fashion</td>
<td>• Provides a practical means of reporting through multiple description and models of the experience.</td>
</tr>
<tr>
<td></td>
<td>(Strauss &amp; Corbin, 1998, p. 8).</td>
<td>• Model of workplace experience is work in progress, to be interpreted by readers, in their own context.</td>
</tr>
<tr>
<td></td>
<td>• Research questions refined during the research process as concepts and relationships emerge</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Balances objectivity in interpretation of events and sensitivity to meanings, relationships and</td>
<td></td>
</tr>
</tbody>
</table>

The methods of grounded analysis used in the study will be outlined in Section 8.4.

7.6 Goal 3: an institutional implementation model (Mixed-Methods)

The third goal of the study is to develop an organisational workplace model for the collaborative development of online curriculum materials and centralised software systems (Section 2.3.3). This goal is described as ‘developmental’ in that it seeks both practical local outcomes and a generalised workplace model of practice. This aspect of the study emphasises the spirit of the Mixed-Methods Paradigm (Section 7.3), drawing from the methods of the action research prototyping activity (Section 7.4.4) and grounded analysis (Section 7.5.2) to synthesise a practical model for organisational activity in Chapter 13. That is, action research and grounded theory are employed as complementary tools in the investigation.
One possible methodological approach might be to apply an integrated ‘theory-grounded action research’ model. Indeed, there have been calls for action research to be strengthened by the application of grounded theory techniques to the theory-building component of the reflective cycle (Baskerville & Pries-Heje, 1999, p. 1). For example, grounded theory notation and methods of coding could be used within the reflection stage of the action research cycle (Baskerville & Pries-Heje, 1999, p. 8).

...little attention has been devoted to the exact processes by which such theories are cyclically developed during the course of action research...most of the action research literature seems to assume that plain deductive logic will operate satisfactorily during the theory-building activities of the action researcher.

(Baskerville & Pries-Heje, 1999, p. 4)

Complete integration, however, may not be possible, as action research typically commences with certain predefined categories and concepts associated with a practical problem, at odds with the usual focus of grounded research only on data (Baskerville & Pries-Heje, 1999, p. 8). The ‘interventionist strategy’ of action research may also lead to an unpredictable range of effects, problematic for the grounded theory sampling process. In addition, the process of grounded theory analysis demands a sense of absorption and level of critical analysis (Strauss & Corbin, 1998, p. 7) that would be compromised by the conflicting demands associated with the already intense engagement in development activities.

Another possibility is for the grounded theory analysis to be undertaken by non-participant researchers operating independently, to examine workplace phenomena in order to inform future practice (Urquhart, 1997, p. 150). On pragmatic grounds alone, the additional personnel required would be beyond the resources of this study.

Given the necessary limitations in resources and ambitious nature of the inquiry, a pragmatic approach is to draw on the already established action research and grounded analysis from the first two goals and focus further investigation on emerging organisational factors. For example, by focusing on particular curriculum projects within the study as institutional case studies, the organisational context of the workplace activity can be illuminated. That is, by reflecting on the action research case studies and emerging empirical evidence of the grounded analysis, particular areas for further analysis can be identified, the data re-examined and extended to generate an organisational model for CFL Systems Development and collaboration.

The research design for this goal therefore draws primarily on the combined methodologies of action research and grounded theory analysis described in Sections 7.4.4 and 7.5.2. Section 8.5 outlines the data and analysis methods applied for this aspect of the study.

7.7 Verification of the research design

If an inquiry is to impact on the world by adding to the body of knowledge or solving a particular problem, then it must allow for external judgements to be made about the consistency of its procedures and neutrality of its findings. It must be able to demonstrate the credibility of that contribution, enable its application by the intended
audience and enable that audience to check on the process by which the findings were obtained (Erlandson, 1993, pp. 28-9).

Inquiries carried out within the traditional paradigm are associated with qualities, such as reliability, generalisability, replicability and cause-effect relationships (Guba & Lincoln, 1989, p. 231). Criteria for judging the validity or rigour of such studies have been well established and include such measures as internal and external validity, reliability and objectivity. These criteria are perfectly workable because they are grounded in the same worldview of the inquiry itself, that is, that knowledge about the world being examined exists independent of the observer. Such traditional criteria, however, become unworkable when applied to a constructivist inquiry, which is grounded in the belief that multiple meanings of the world are constructed by individuals through ongoing interaction with others (Section 4.2). That is, a fundamental problem occurs, when the criteria adopted for judging the quality of the inquiry is based on different philosophical assumptions (Guba & Lincoln, 1989, p. 235).

Guba and Lincoln have proposed standards that can be used to establish and improve the ‘trustworthiness’ of a naturalistic inquiry that parallel the traditional criteria, using the terms of ‘credibility’, ‘transferability’, dependability’ and ‘confirmability’ (Creswell, 1998, p. 197; Erlandson, 1993, p. 29; Guba & Lincoln, 1989, p. 236). These criteria acknowledge the irreducible complexity of an authentic social setting, the multiple perspectives and meanings drawn from the inquiry by individuals, which must be reflected in the research design and methods. They are compared with the equivalent traditional criteria in Table 7.6 and expanded below.

Table 7.6 Criteria for verifying research based on traditional and naturalistic inquiry paradigms

<table>
<thead>
<tr>
<th>Traditional inquiry: Proving validity</th>
<th>Naturalistic/constructivist inquiry: demonstrating ‘trustworthiness’</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal validity</td>
<td>Credibility</td>
</tr>
<tr>
<td>One-to-one relationship between objective reality and the findings; proof of a causal relationship between variables.</td>
<td>Compatibility between the constructed realities of the respondents and the reconstructions attributed to them in the inquiry.</td>
</tr>
<tr>
<td>External validity</td>
<td>Transferability</td>
</tr>
<tr>
<td>Findings shown to be of generalised applicability within defined contextual parameters.</td>
<td>Others are able to decide on the application of findings in other contexts, based on judgment of overlap of contexts between individual cases.</td>
</tr>
<tr>
<td>Repeatability</td>
<td>Dependability</td>
</tr>
<tr>
<td>Findings can be replicated using the same method in equivalent contexts.</td>
<td>Changes in methodology can be tracked and attributed to particular sources, or better insights.</td>
</tr>
<tr>
<td>Objectivity</td>
<td>Confirmability</td>
</tr>
<tr>
<td>Free from bias of researcher.</td>
<td>Data and processes for judgements made can be tracked.</td>
</tr>
</tbody>
</table>

(after Guba & Lincoln, 1989, pp. 233-43)

7.7.1 Credibility (c/f internal validity)

Rather than seeking to validate a one-to-one relationship between the findings of an inquiry and the phenomena under investigation, a naturalistic inquiry cannot make the assumption of a single objective reality. The ‘credibility’ of such studies is marked therefore by the compatibility between the multiple constructed realities of the respondents and those that are attributed to them by the inquiry (Erlandson, 1993, p. 29). This means the descriptions generated by the inquiry must credibly represent the similarity and difference between the various interpretations of the individuals and groups who contributed the data. There are a number of strategies that can
contribute to the interpretation of multiple realities, which can be affirmed by individuals within their own context.

Prolonged engagement and persistent observation in the field makes it possible for the researcher to establish trust within a community, learn about the culture and uncover distortions or misinformation, all contributing to the development of deeper understanding of the situation (Creswell, 1998, p. 201).

Peer debriefing provides an opportunity for the researcher to step outside the context of study to discuss the findings, conclusions and tentative analyses with people external to the situation, in order to refine or possibly redirect the inquiry process and to reduce physiological stress often associated with fieldwork (Erlandson, 1993, p. 31; Guba & Lincoln, 1989, p. 237).

Member checks of the data and interpretations should be verified by the stakeholder groups and individuals represented within the study. These may occur throughout a study and provide an opportunity to correct errors and interpretations, further illuminate respective understandings of participants and researcher and provide a formal confirmation of the representation made in the study.

Triangulation is a way of eliciting the various and divergent constructions of reality that exist within the context of the study, by obtaining data from different sources and employing different theoretical schemes and methods of analysis (Erlandson, 1993, p. 31). I have referred to this as ‘bracketing’ (Section 7.3).

The credibility of this study, that is, how faithfully it portrays the variation and richness of multiple interpretations of participants, has been addressed in the research design by the following approaches:

- extended engagement over the main period 1996–2000, supplemented by case study data from 1991–4;
- colleagues, collaborators and management staff have provided both formative input and final verification of specific aspects of the representations made in the narrative history and grounded analysis;
- different perspectives on the narrative history of colleagues, collaborators, management staff, external individuals and family have been represented;
- a review of whole study has been undertaken by the current Director of TeLaRS;
- data has been drawn from a variety of sources, such as formal documentation, email communications, software artefacts, reflective journals and interviews;
- the Mixed-Methods approach has provided bracketed representations in the form of case studies, narrative history and qualitative and quantitative analysis of phenomena; and
- different data sets are used within the two separate innovation case studies.

7.7.2 Transferability (c/f external validity)

External validity or generalisability in traditional inquiries refers to how well causal relationships proposed can be extended to other contexts and settings (Guba & Lincoln, 1989, p. 234). Conventional inquiries therefore tend to focus just on those aspects of an inquiry that do not shift across contexts (within the bounds of probability) and insist on random selection from a population to enable generalisations to be made (Erlandson, 1993, p. 32). Within the constructivist paradigm, however, no true generalisations are possible; all observations are defined by
the specific contexts in which they occur. This does not mean that knowledge gained from one context will have
total relevance for other contexts. Rather, demonstrating transferability is up to those who want to apply the
findings elsewhere, who must establish the degree of overlap in order to make tentative judgements about their
applicability. That is, the onus of establishing transferability has shifted to the reader and it is up to the
researcher to design the inquiry to ensure this is possible.

Rich, thick description allows the reader to make decisions regarding the transferability of findings (Creswell,
1998, p. 203). The intention is to provide an extensive and careful description of the time, place, context and
culture in which the particular study findings were based, to facilitate judgements on the part of others who may
wish to apply the study in their own situations (Guba & Lincoln, 1989, pp. 241-2).

Purposeful (theoretical) sampling of data deliberately exploits the developing insights of the researcher to focus
data collection in order to improve the emerging picture with rich detail, in contrast to conventional studies that
depend on random sampling to build aggregated qualities (Erlandson, 1993, p. 93).

This study facilitates the transferability of its findings by others, by:

- providing a narrative history of the development process that evokes a strong sense of the workplace
  experience through rich detail, images and plain English style of writing;
- providing sections that address specific perspectives, such as the narrative (all stakeholders), descriptions of
  OCCA (teachers and support staff), OCCA technical descriptions (developers), educational case studies
  (teachers) and organisational model (managers);
- using grounded analysis techniques to classify and illustrate phenomena emerging from the development
  experience, complementing the narrative history; and
- providing comprehensive case studies of authentic curriculum projects as exemplars of the educational
  application of the CFL system and collaborative organisational practice.

7.7.3 Dependability (c/f repeatability)

The qualities of reliability, predictability and stability in traditional studies require that an application of the
same method in an equivalent context will replicate the results (Erlandson, 1993, pp. 33-4). In a constructivist
inquiry, however, changes in methodology will occur during the process of the inquiry due to changing
understandings of the researcher. The dependability of the study can be increased by tracking and explaining the
sources of such variability, through errors, reality shifts or better insights.

A dependability audit makes possible an external check on the processes by which the study was conducted.

This study demonstrates its dependability by:

- mapping the variation in design approach across the production period (Section 9.2.2); and
- maintaining a detailed audit trail of the action research development derived from documents, software
  artefacts and reflective journals reported in the narrative history (Chapter 11), grounded analysis of (Chapter
  12) and case study (Section 13.3);
• demonstrating a significant shift in perspective from the Developer-centred Innovation Model (Section 12.4.2) to the organisational model in Chapter 13; and
• documenting the longer term shift from my initial conceptual understanding of CFL production (Figure 1.3, p. 10) to a generalised portrayal of innovative research practice seen from an organisational perspective (Chapter 13).

7.7.4 Confirmability (c/f objectivity)

Traditional studies focus on the objectivity of the researcher, that is, the methodology must ensure that the findings are independent of the researcher’s values, biases, or political persuasions (Guba & Lincoln, 1989, pp. 242-3). In a constructivist inquiry, rather than seeking assurances of objectivity, the integrity of the findings depends on being able to track the constructions and assertions back to their source through a confirmable process and explicit analysis logic.

A confirmability audit provides an adequate trail for the analysis process to be traced, in order that others can make judgements about the inquiry (Erlandson, 1993, p. 35). This can be carried out in conjunction with the dependability audit above. In this study:

• the processes of data analysis are mapped in Chapter 8;
• the action research process itself is mapped in detail in the narrative form and grounded analysis;
• the visual maps in Appendix 9 (p. 290) provide a detailed chronological listing of key events and phenomena representing the raw data from the initial grounded categorisation; and
• illustrative cross-references are made between the different analysis representations.

Finally, a degree of external accountability of approaches adopted and collaborations over the extended study period is provided within some 34 published academic papers (Fritze & Ip, 1998; Fritze, Johnston & Kemm, 1998; Fritze & Kemm, 2000; Fritze & McNaught, 1994, 1996; Fritze & McTigue, 1997; Fritze, Welch & Ji, 2000; Fritze, Kavnoudias, Kemm & Williams, 2001b; Grant et al., 1995; Ip, Canale, Fritze & Ji, 1997; Ip & Fritze, 1998a, 1998b; Ji, Ip, Canale & Fritze, 1998; Jones & Fritze, 1996; Kavnoudias, Fritze, Kemm & Williams, 2000; Kemm, Kavnoudias, Fritze & Williams, 2000; Kemm, Kavnoudias, Weaver et al., 2000; Kemm, Williams, Kavnoudias & Fritze, 2001; Kemm, Williams, Kavnoudias, Fritze & Weaver, 2001; Kennedy, 2001; Kennedy & Fritze, 1998; Kennedy, Fritze & McTigue, 1997a; Kennedy, McNaught & Fritze, in press; Kennedy, Fritze & McTigue, 1997b; Margetts, Ure, Raban & Fritze, 2002; McNaught et al., 1993; McNaught et al., 1995; McTigue, Tregloan, Fritze, McNaught & Hassett, 1995; McTigue, Tregloan, Fritze et al., 1994; McTigue, Tregloan, Fritze, McNaught, Hassett et al., 1995; McTigue, Tregloan, McNaught & Fritze, 1994; McTigue, Tregloan, McNaught, Fritze et al., 1994).

In summary, the above verification criteria are grounded in a philosophical perspective of constructivist inquiry, which is congruent with philosophical approach of the study and strengthened by the Mixed-Methods approach adopted. The design of the data analysis methods discussed in the next chapter further illuminates the manner in which this study has addressed the requirements of ‘trustworthy’ constructivist inquiry.
7.8 Summary

The challenge of this inquiry is to acknowledge the complexity and problematic nature of the higher education setting, the practical and open-ended goals set for the inquiry, conflicting paradigms that might guide action in the field of CFL Development and a need to address multiple perspectives of stakeholders.

Given this practical and problematic nature of the undertaking, I have aligned the research approach with the Eclectic-Mixed Methods-Pragmatic Paradigm drawn from Reeves’ framework of dominant inquiry paradigms for instructional evaluation. This approach openly borrows methods from other traditional, interpretivist and postmodern paradigms, in order to best solve the practical problems at hand. Fundamental assumptions of the Mixed-Method Paradigm are:

- ‘authentic’ problems in complex settings requiring practical solutions;
- openness to seek alternative approaches to solving real world problems;
- multiple perspectives of various stakeholders that must be addressed;
- multiple paradigms that shape the language, agendas, responsibilities, accepted standards and methods of communities and individuals; and
- pragmatism necessary to deal with the complexity of the setting, acknowledged limits of the inquiry tools and limited resources available to the researcher.

Although closely related, the three goals of the study have different purposes as outlined in Chapter 2 and call on the different methods of interpretivist, critical and Mixed-Methods inquiry.

Goal 1, to develop a generic pedagogical software system, draws primarily on an action research prototyping methodology from the field of Information Systems. This approach represents a fluid interpretation of a development approach that remains open to change in methodological approach and researcher role as the CFL system and project collaborations evolve. The outcome of this aspect of the study will be the software system itself.

Goal 2, to improve understanding of the development process, uses a grounded theory analysis of the software development experience. This is approached with an open mind, allowing the theory to emerge from the data, rather than attempting to fit the experience to pre-conceived theories. Outcomes of this aspect of the study aim to represent the experience in rich detail, with emerging themes and categorisations setting up a prototypical model that can inform discussion and extensions in the light of further studies.

Goal 3, to develop an institutional model for collaborative development and implementation of CFL materials, is interwoven with the software development and grounded reflection process. It will examine models of collaboration between curriculum production and research into new technologies and ways of teaching. This aspect of the inquiry therefore represents a mixed-method approach, drawing on both action research and grounded theory. The output of this aspect of the study will include descriptive case studies and an emergent model of organisational action.
The verification of the research design of any study must be undertaken from a perspective aligned with the philosophical orientation of the inquiry itself. For this study, the criteria for judging a naturalistic inquiry are appropriate, given its constructivist underpinnings, and contrast greatly with traditional notions of internal validity, generalisability, repeatability and objectivity. Instead, the trustworthiness and usability of the study are reflected in its:

- credibility – the compatibility between the constructed realities of the respondents and the reconstructions attributed to them;
- transferability – how others are able to decide on the application of findings in other contexts, based on judgment of overlap of contexts between individual cases;
- dependability – that changes in methodology can be tracked and attributed to particular sources or better insights; and
- confirmability – that data and processes for judgements made can be tracked.

The study addresses these criteria through its prolonged engagement in authentic problems, rich and bracketed representations of contextual detail, portrayal of alternative perspectives and the use of multiple research methods.

The specific analysis methods and data management relating to the three goals are outlined in Chapter 8.
CHAPTER 8. Methods of analysis

8.1 Introduction

In this chapter the research methods and data associated with the three goals of the study are outlined. The research design follows directly from the methodologies established in the previous chapter. Thus, the first software production ‘action’ goal is guided by an Information Systems action research prototyping methodology. The second ‘interpretive’ goal, to increase understanding of this workplace experience, uses a grounded theory methodology. Lastly, the ‘development’ goal, to create a practical organisational model for a collaborative approach to CFL Systems Development, uses a Mixed-Methods approach.

8.2 Overview of research goals, data and outcomes

There are two main development periods examined in the research: the CFL systems development undertaken within a Central Unit between late 1996 and late 2000; and a previous development set within the Chemistry Department between late 1991 and late 1994 that serves as an additional case study. The relationship between
The data, research goals and stages of inquiry is mapped in Figure 8.2. The grounded analysis was primarily carried out between 2000 and 2002, with the organisational analysis commenced in 2001. The grounded analysis of Goal 2 used data from both the TutorialTools and generic software developments. In turn, findings from this were used in the organisational analysis of Goal 3, which was also informed by the ‘Group Project’ curriculum case study.

![Diagram](image)

**Figure 8.2** Components of the study and data sources contributing to the three goals

Dotted lines indicate continuation beyond the study

The principal research outputs of the thesis are mapped in Figure 8.3 (see p. 107). For example, different representations of the Goal 1 product are reported in Chapters 9 and 10, with the evolution of project aims (Section 9.2) derived from the grounded analysis of Goal 2. The research database, raw categorisation of properties and dimensions, and ResearchMap displays associated with Goal 2 are reported in this chapter (indicated in bold). These in turn inform the narrative history in Chapter 11 and alternative perspectives in Section 11.4. In this case, the history and categorisation were produced in an iterative manner, as indicated by the double-headed arrow. The third organisational goal draws on an action research case study and outcomes of the grounded research to generate a Collaborative Developmental Research model in Section 13.3.

Methods and data used for the three goals are discussed separately in the following sections.

### 8.3 Action research prototyping of generic software: Goal 1

Goal 1 follows an action research prototyping approach in the development of a generic CFL system, as discussed in Section 7.4. This involved an iterative process of design, prototype construction, testing and reflection on outcomes, commencing with an adaptation of the initial TutorialTools software (Section 2.3.1). Figure 8.4 (see p. 107) indicates how the generic online development was sanctioned by Central Unit policy and informed by numbers of independent curriculum projects, primarily promoted by the central funding program as described in Section 1.4.
Figure 8.3  Relationship between the principal outputs of study goals and thesis structure
(Contribution of this chapter in bold)

My engagement with curriculum projects was necessarily opportunistic in nature, with my role varying from educational consultant to associate applicant and/or collaborator in particular projects. The opportunity to explore ideas with teachers across multiple projects underpinned my understanding of the multi-disciplinary requirements of the generic system. Data generated from the development came in the form of communications, documentation, reflective journals and software versions.
8.3.1 Form of action research method

The generic software development is characterised by two contrasting purposes:

- development of a generic learning system; and
- production of individual curriculum projects.

To clarify this distinction, different forms of the Information Systems action research prototyping approach introduced in Section 7.4.3 are examined. The characteristics of initiation, primary goals, structural guidance, authority, process model and formalisation are summarised in Table 8.1 and discussed individually below.

Table 8.1 Characteristics of action research prototyping approach adopted

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Generic system development</th>
<th>Curriculum project production</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Initiation</strong></td>
<td><strong>Researcher:</strong> Opportunity to re-develop prior software for the generic online use.</td>
<td><strong>Collaboration:</strong> Triggered by multiple funding opportunities for innovative curriculum developments.</td>
</tr>
<tr>
<td>Genesis of the action research project?</td>
<td><strong>System design:</strong> Development of generic multi-discipline learning system.</td>
<td><strong>Curriculum design:</strong> Improvement in learning and teaching, incorporation of ICT into teaching.</td>
</tr>
<tr>
<td><strong>Primary goals</strong></td>
<td><strong>Identity:</strong> Developer and researcher the same person and has control of direction of generic system.</td>
<td><strong>Practitioner:</strong> Lecturer is responsible for curriculum project and is able to terminate involvement.</td>
</tr>
<tr>
<td>Primary goals of the action research?</td>
<td><strong>Iterative prototyping:</strong> Software prototyping of the generic system via discipline projects.</td>
<td><strong>Iterative prototyping:</strong> Prototyping of learning designs within each curriculum project.</td>
</tr>
<tr>
<td><strong>Structure</strong></td>
<td><strong>Fluid:</strong> Opportunistic response to collaborative involvement opportunities.</td>
<td><strong>Fluid:</strong> Responsive to emerging understandings within curriculum delivery constraints.</td>
</tr>
<tr>
<td>Degree of structural guidance?</td>
<td><strong>Informal:</strong> Sanctioned within general aims of the Unit/University and broad role statements of researcher.</td>
<td><strong>Both informal and formal:</strong> Informal consultancy relationship or formal commitment via funding proposal agreements, development contracts.</td>
</tr>
</tbody>
</table>

(Revised from Table 8.1, after Avison et al., 2001, p. 38; Baskerville & Wood-Harper, 1998)

**Initiation**

The research was triggered primarily by the opportunity to adapt my earlier TutorialTools software for online use within independent curriculum projects supported by the Central Unit (Figure 8.4). The ‘Initiation’ dimension of the generic system development was, therefore, primarily ‘researcher-oriented’.

Later in 1997, however, the University commenced a major funding program to transform curricula through innovative use of ICT (Section 1.4). This became a major pathway for academics to initiate curriculum projects that could further underpin the generic system development (Figure 8.4). These initiatives provided a strategic opportunity for me (a) to consult with a wide range of teachers and (b) formally collaborate in funded projects (Appendix 7, p. 287). Thus, initiation of the action research occurred at a number of levels and involved the institution, Central Unit, teachers and developer, with different, but inter-related, mechanisms for the generic and curriculum components of the development.

**Primary goals**

‘Primary goals’ are a major influence on the form of action research approach (Baskerville & Wood-Harper, 1998, p. 95). There are, however, multiple goals within this development. The primary goal is to develop a
software system, but this in turn depends on multiple individual curriculum projects. Each of these has its own specific curriculum goals, driven by teachers not necessarily interested in the generic development goal. While evaluations of the curriculum projects are reported in Chapter 10, in most cases this has been the responsibility of individual teachers and not directly within the scope of this research study. That is, there are clear distinctions between the generic and curriculum goals of the research, reflecting the interests of researcher and teacher.

**Structure**

Given the likelihood of conflicting research purposes, the level of structural guidance implicit in the research method is important (Baskerville & Wood-Harper, 1998, p. 95). The approach within both generic and curriculum components of the study reflects a fluidity associated with iterative prototyping, making possible wide exploration of alternatives from the earliest stages of development (Mason & Carey, 1983, p. 349). For the curriculum projects, however, the overriding requirements of course delivery impose an external rigidity not associated with the more open-ended generic development. Such conflicting requirements highlight an area of potential difficulty for the research.

**Authority**

The dual purposes of generic research and curriculum practice make it necessary to clarify where project control lies, for example, how a project might be terminated, or a new development cycle initiated. The ‘Authority’ dimension indicates who is in charge. Here again, the generic development and individual curriculum projects vary. As researcher, I shaped the direction of the generic component within the boundaries of my position, but responsibility for individual curriculum project management lay with the individual teacher. This is an important point. The research method must accommodate the contrasting interests of researcher and teacher, while also recognising their mutual obligations. The nature of my particular position within the institution, as someone sanctioned to engage in technology mediation, underlies the manner of connection between institutional, teaching and technical requirements (Taylor, 2001).

**Process model**

Baskerville and Wood-Harper refer to the process model as a major dimension of action research (Baskerville & Wood-Harper, 1998, pp. 94-5). For example, the ‘traditional’ form is characterised by alternate cycles of action and problem diagnosis; a ‘reflective’ process model is associated with action learning (Argyris & Schön, 1978); and a ‘linear’ model with consulting. In this study, the approach is primarily ‘iterative’, involving prototyping cycles within each curriculum project as well as across projects in the context of the generic development. The latter cycles are revealed, for example, as ‘phases’ of development (Section 9.2.1). The iterative prototyping loop within Figure 8.4 should therefore be viewed as ‘wheels within wheels’. Exits from these iterative cycles came from completion of individual curriculum projects or a decision that the design approach was not appropriate for the curriculum project requirements.

Software prototyping is a fundamental mechanism in certain action research process models for overcoming communication problems between researcher/developer and user (Mason & Carey, 1983, p. 348). This is a critical point. Prototyping not only facilitates iterative development and understanding of a product solution, but is also a vehicle of expression, understood by both researcher and academic user. Prototyping can generate a new vocabulary for describing complex product features (Schrage, 1996, p. 198). I used software prototypes in each curriculum project to facilitate initial discussion and test ideas. In fact the TutorialTools software served as the initial ‘prototype’ model for the generic system. Later, early prototypes of a graph-sketching tool were used to
elicit teachers’ requirements that were implemented in the final product (Kennedy, 2001, p. 172). In general, software prototypes evolved from version to version and from project to project, rather than being independently created. At times, however, I was prepared to drop certain ‘families’ of the software when fundamental flaws were revealed.

Another aspect of the iterative action research cycle relates to reflection on practice. Reflective journals are a well-established method of facilitating reflective and critical thinking and deepening personal understanding (Bain, Ballantyne, Packer & Mills, 1999, p. 51). As a qualitative research technique, journal writing can allow participants an active voice (Janesick, 1999, pp. 522-3). It enables them to focus totally on the point at hand and provides an additional data set for them to outline, describe and explain their role. This process of reflection also provided key data for the analysis of the workplace development experience, as part of Goal 2 (see Section 8.4).

**Formalisation**

Finally, the action research approach in the study can be categorised by its degree of ‘formalisation’. This describes the nature of the agreement between participants, for example, by using written contracts (Avison *et al.*, 2001, p. 35). Again, the contrast between the generic and curriculum aspects is apparent. At one level, the generic development was broadly sanctioned by University and Central Unit strategy statements, such as the Central Unit policy to:

…collaborate with academics in the formation of teams of specialists so as to plan, develop & evaluate transformed units, subjects & courses that use multimedia & educational technology, for delivery to students of The University of Melbourne, including materials delivered on the Web [and engage in] development and testing software frameworks for the delivery of teaching & learning materials… investigating uses in teaching & learning of new technology as it becomes available.

(University of Melbourne, 1996, p. 19)

At the curriculum project level, my involvement ranged from informal consulting to formally documented projects in which I was a co-applicant. These successfully funded projects were subject to a formal peer review process, although it needs to be acknowledged that ‘action research’ was not referred to and the underlying ‘generic’ development aspect only alluded to. Funding criteria were clearly focused on production, rather than research. To address this difficulty, I therefore adopted a pragmatic, low-key approach to the research component of curriculum projects by:

- raising the possibility of formal action research collaboration only in certain projects, once trust and understanding had been developed;
- placing the action research emphasis on my own work practice, for example, by maintaining reflective journals of the process; and
- encouraging the process of reflection and collaboration through ‘accepted’ academic channels, such as writing joint conference papers and regular project meetings.

Finally, it is worth noting that the generally informal and fluid character of the action research approach described aligns well with the prototyping process model. More formal approaches that employ written
specifications for complex interactive software applications do not easily convey a realistic sense of system requirements and how it might fit the user’s needs (Mason & Carey, 1983, p. 347).

8.3.2 Key features

The action research prototyping method applied in the development of a generic learning software system exhibited a number of key features:

- multiple opportunities for consulting and curriculum project collaborations underpinned the multi-disciplinary requirements of the ‘generic’ system;
- software prototyping provided a means of testing and describing system functionality in a form acceptable to both developer and teachers;
- a fluid interpretation of the research approach was necessary to deal with emerging curriculum opportunities and changing technologies and understandings;
- the generic software model iteratively developed across different curriculum projects;
- individual curriculum developments used iterative prototyping within projects, employing specific versions of the generic model; and
- a pragmatic level of research formalisation acknowledged the realities of academic and management culture and variation across projects.

Outcomes of this action research goal lie primarily with the emergent generic software product itself. These are reported as (Figure 8.3):

- various descriptions of the emerging generic learning system (Chapter 9); and
- case studies and evaluations of curriculum application of the software by teachers (Chapter 10).

Inherent within these outcomes lies a generalised approach to learning and teaching exemplified in curriculum implementations and aligning with the Pragmatic Educational Requirements Guide of Section 5.5. The development also provides empirical evidence to support other goals of the study, to analyse the workplace experience and develop a practical organisational model for research/teaching collaboration. Conversely, the interpretive analysis in chapters 11 and 12 provides an audit of the action research process (Section 7.7).

Data originating within the action research, in the form of reflective writing, evolving software versions, documents and communications, are discussed in the context of the grounded analysis in the following section.

8.4 Grounded analysis of the workplace experience: Goal 2

The initial focus of the second research goal was on understanding the workplace experience of the generic online software development. A grounded theory methodology (Section 7.5) informed the analysis so that a representation of the experience came from the data, rather than attempting to fit the evidence to an existing theory of development. The analysis complements the action research in Section 8.3, by portraying a comprehensive description of events and patterns of activity, in effect an audit trail of the action research process. This case study is integrated with an historical analysis of the previous TutorialTools development.
within a departmental setting between 1991 and 1994, which provided the starting point for the generic online version in 1996 (Figure 8.2).

### 8.4.1 Data collection

The principal data upon which the grounded analysis is based are summarised in Table 8.2. These data are drawn from diaries, design notes and personal communications for the periods 1991–1994 and 1996–2000. Regular workplace documentation was supplemented by reflective writing undertaken within the action research software production (Section 8.3).

#### Table 8.2 Principal data sources generated within the development process

<table>
<thead>
<tr>
<th>Source</th>
<th>Period</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1996–1997</td>
<td>Log of events and daily timetable of tasks, meetings etc.</td>
</tr>
<tr>
<td></td>
<td>1998–2000</td>
<td>As above but incorporating regular notes on current issues and personal reflections on events averaging approximately 2000 words/week.</td>
</tr>
<tr>
<td></td>
<td>1998–2000</td>
<td>As above with additional regular extended reflections on events and issues. 21 x 120 page A4 journals averaging 500–2000 words per week.</td>
</tr>
<tr>
<td>Documents</td>
<td>1991–1994</td>
<td>Published papers, project and technical documentation, grant applications, staff appraisal notes and correspondence.</td>
</tr>
<tr>
<td></td>
<td>1996–2000</td>
<td>Published papers, project and technical documentation, grant applications and formal correspondence.</td>
</tr>
<tr>
<td>Email</td>
<td>1996–2000</td>
<td>Records of personal email transactions.</td>
</tr>
<tr>
<td>Software</td>
<td>1996–2000</td>
<td>Evolving versions of approximately 30 distinct software components developed, gathered from Web sites and software archives.</td>
</tr>
</tbody>
</table>

Evidence for the analysis was drawn from tens of thousands of individual pieces of information from a variety of electronic and print-based forms (Table 8.2). The data distribution is also mapped in Figure 8.8 and Figure 8.9. Data from the earlier period 1991–4 were far more limited and primarily in the form of short diary entries and surviving documents, such as reports to management and staff appraisal notes. Over this period there were few evolving software ‘artefacts’ due to the nature of the software development.

Within the main research period 1996–2000, I used large format diaries to record meetings, work activities and reflective comments. In 1998, I changed to A4 journals containing design notes and a reflective commentary. The source of data is, therefore, less important the nature of the entries. Between 1996 and 1999, programming focused on component-based software, providing a trail of ‘software’ artefacts.

As indicated in Figure 8.2 (p. 106), the interpretive analysis of the workplace experience commenced in the later stages of the generic system development in 2000, becoming integral, in fact, with the action research process during the production of the ‘Group Project’ in Physiology (Section 13.3). Thus, the interpretive analysis at this point was in one sense part of the action research process itself, and in another, an arms’ length analysis of a development experience (see also Section 8.5.1).

### 8.4.2 Overview of grounded analysis methods

The grounded analysis progressed through stages, beginning with the creation of analysis instruments and initial sampling of data (row 1 in Table 8.3). Refinements to the instruments and data collection continued in parallel with writing of the narrative history. There were five strands to the research employing particular instruments...
and methods: data collection, categorisation, visualisation, description and integrative analysis (columns A-E). These activities occurred in parallel and within iterative cycles of reflection and refinement, rather than as a stepwise sequence of tasks. The five strands of the analysis are discussed in the following sections.

Table 8.3 Overview of stages and strands of the Goal 2 grounded analysis process

<table>
<thead>
<tr>
<th>Strand</th>
<th>A. Data collection</th>
<th>B. Categorisation</th>
<th>C. Visualisation</th>
<th>D. Description</th>
<th>E. Integrative analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage 1</td>
<td>Construct prototype database using sample data.</td>
<td>Form initial properties &amp; dimensions.</td>
<td>Build prototype visualisation tool.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stage 4</td>
<td>Reflect on emerging representations from B and C, input from collaborators</td>
<td>Revise data entries, categorisation and visualisation methods</td>
<td></td>
<td>Deconstruction of the workplace experience and innovation model (Sections 12.3, 12.4).</td>
<td></td>
</tr>
<tr>
<td>Stage 5</td>
<td></td>
<td>Statistical representations of data (Ch. 12, p. 190).</td>
<td>Alternative perspectives on narrative history (Section 11.4).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stage 6</td>
<td>Reflect on emerging representation with collaborators, revise model, narratives and draw conclusions</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

8.4.3 A. Sampling and management of data

The critical ‘Data collection’ strand of the analysis (column A) involved selecting, focusing, summarising, abstracting and transforming the large body of data to facilitate its treatment (Miles & Huberman, 1994, p. 10). I created a specialised research database for transcribing the evidence into electronic records, which could be managed more efficiently than the original paper copies or computer files. Each database record was an information ‘item’, representing, for example, whole documents, software artefacts or specific journal entries.

Selection of relevant items from the vast range of information was time-consuming. I initially focused on a small range of data to develop the database structure and initial descriptive categories (A1, B1 in Table 8.3). Once the instrument was established, sampling was extended to the full periods of 1996–2000 (A2) and 1991–4 (A3). Progressive refinements were made to both the instruments and entries in the light of findings emerging from the strands of the analysis (Section 7.5.1). My focus was on data directly related to my personal experience and I examined all documents, communications and files related to my involvement that I had reasonable access to.

In its final form, the research database provided an efficient means of data entry, sorting, searching and classification, as indicated in the main entry screen in Figure 8.5. The data entry process involved defining a succinct title, inserting the source text, summarising key aspects, and making analysis notes and preliminary
categorisations against the emerging classification fields. A screen snapshot or diagram could be entered as a visual reminder of particular software stages or documents.

**Figure 8.5** Research database main entry screen showing a single record ‘item’

Navigation and management tools are in the top menu bar

### 8.4.4 B. Categorisation of data

The ‘Categorisation’ strand of the grounded analysis (column B in Table 8.3) went hand-in-hand with data collection and involved a grounded analysis of data to determine their properties and dimensions (Strauss & Corbin, 1998, p. 57). This required careful interpretation of meaning revealed about the experience and situation. The interplay between my own position as participant and researcher must be acknowledged. It is not possible to undertake such an interpretative analysis as an entirely neutral and independent observer. This is both a strength and weakness of the analysis, and is a characteristic of this form of research.
I attempted to utilise my sensitivity to the meaning behind the data, while maintaining a self-awareness of my position as researcher and natural tendency to invoke my existing understandings (Strauss & Corbin, 1998, p. 59). The act of interpretation of each item therefore involved attempting to stand back and ask:

- what was going on here?
- what is the significance of this object?
- what were my feelings? and
- how does this relate to the other data at that point, and within the emerging story?

For example, an item of data may have described a particular version of the software. By itself this says nothing about personal feelings, or the intent behind it, so the categorisation process involved reconstructing the contemporary situation from related journal, diary and communication data, sensitised by my detailed knowledge and current perceptions of the situation. Thus, in addition to simply describing the software artefact itself, I could reasonably consider how it evoked other properties, such as workplace ‘action’, ‘personal feelings’, or ‘links’ to other people. Against such properties, I could define dimensions such as ‘programming’, ‘stress’, or ‘colleague’.

The main database record attributes developed at the conclusion of the categorisation in stages B1–4 (Table 8.3) are indicated in Table 8.4 (refer also to Appendix 8, p. 289). A total of 502 records were transcribed and categorised.

Table 8.4 Key database record properties emerging from the categorisation process

<table>
<thead>
<tr>
<th>Properties</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
<td>Date of activity, software version, journal entry or document represented in the record.</td>
</tr>
<tr>
<td>End Date</td>
<td>End date for a period of activity (defaults to Date).</td>
</tr>
<tr>
<td>Weighting</td>
<td>Scaling factor for record accounting for time fraction of situation described (defaults to 1.0).</td>
</tr>
<tr>
<td>Title</td>
<td>Short descriptive title of record used as key record identifier.</td>
</tr>
<tr>
<td>Type</td>
<td>Status of the record, used to select certain views of data, for example, milestone, product, reflection, or snapshot.</td>
</tr>
<tr>
<td>Source</td>
<td>Original data source: conversation, diary, document, email, journal, seminar, program.</td>
</tr>
<tr>
<td>Notes</td>
<td>Summary, or where possible, whole content of source.</td>
</tr>
<tr>
<td>Analysis</td>
<td>Notes made about significance of item, thoughts, or possible relationships.</td>
</tr>
<tr>
<td>Phase</td>
<td>Particular stage of the development, typically related to stage of software development.</td>
</tr>
<tr>
<td>Action(s)</td>
<td>Any action(s) by me related to the record, for example, to collaborate, committee, consult, discover, discuss, document, evaluate, funding, ID, implement, investigate, negotiate, plan, present, program, promote, publish, reconceptualise, rethink, reflect, self-ed, staff_dev, or write (24 dimensions).</td>
</tr>
<tr>
<td>Feeling(s)</td>
<td>My personal feeling(s) related to situation: competitive, concerned, disappointed, excited, interested, overworked, pleased, or stressed.</td>
</tr>
<tr>
<td>Link(s)</td>
<td>Individual(s) or group(s) directly connected to the record entry: academic, colleague, contract, CSHE, edUnit, extAcademic, extCompany, InfoDiv, localManagement, MMunit, projectTeam, students, U21, UniManagement, or UniFacility.</td>
</tr>
<tr>
<td>Connection(s)</td>
<td>Identity of people or groups directly connected with the record in some way (34).</td>
</tr>
<tr>
<td>Project</td>
<td>Curriculum project associated with the record (28 dimensions).</td>
</tr>
<tr>
<td>Software</td>
<td>Name assigned to software object or component (40 dimensions).</td>
</tr>
<tr>
<td>Technology(s)</td>
<td>Software technology(s) associated with record, for example, HTML, HyperCard, Java, Shockwave, XML (21 dimensions).</td>
</tr>
<tr>
<td>Image</td>
<td>Diagram or software screenshot representing the item.</td>
</tr>
</tbody>
</table>
The properties and dimensions emerging from this classification process were iteratively refined across all stages of the analysis. The process involved constantly moving back and forth between items and re-interpreting them in order to arrive at an increasingly consistent classification framework.

Certain properties in Table 8.4 related to basic management and organisation of the records, for example, ‘Date’, ‘Title’, ‘Source’, or ‘Type’. Other properties were more interpretive in nature such as ‘Action(s)’, ‘Connection(s)’ or ‘Feeling(s)’, each of which may have had multiple dimensions assigned. Some of the dimensions emerging at this stage were formative in nature and not incorporated into later analysis stages. Dimensions used in the final Classification Framework are reported in detail in Section 12.2.

![Figure 8.6](image_url)

Additional database report formats facilitated comparison and re-classification of records, for example, in Figure 8.6 above. By searching on particular criteria, clusters of record items could be checked for consistency, and properties and dimensions created or edited.
8.4.5 C. Visualisation of data

The third strand of the analysis (Column C in Table 8.3) involved representing the data in alternative ways to reveal otherwise invisible patterns. Qualitative information dispersed over many pages of text is difficult to represent holistically. It is generally bulky, ordered only sequentially and can be taxing to analyse. While techniques for displaying statistical information from survey data are well understood, there are fewer, agreed-on qualitative methods and the researcher may have to craft their own data displays suiting the individual needs of the study (Miles & Huberman, 1994, pp. 92-3).

You know what you display. Valid analysis requires, and is driven by, displays that are focused enough to permit a viewing of a full data set in the same location, and are arranged systematically to answer the research questions at hand. … Most important, the chances of drawing and verifying valid conclusions are much greater than for extended text, because the display is arranged coherently to permit careful comparisons, detection of differences, noting of patterns and themes, seeing trends, and so on.

(Miles & Huberman, 1994, pp. 91-2)

The two main display techniques used in the second and third stages of the analysis were optimised database reports, a specially developed visual mapping application and statistical representations of data (Table 8.3).

Display listings

The optimised display listing provided a 173–page summary of the entire dataset, focussing on the title, date and note properties. This listing provided the foundations of the narrative story developed in strand D of the analysis. The printout in Figure 8. lists items categorised as ‘milestone’ events, thus representing a shortened history of main turning points of the developments.
To shed further light on the complex patterns of events and relationships in the data, I developed a specialised ‘ResearchMap’ program in Macromedia Director early in the analysis. This enabled me to create chronological arrays with which I could compare and contrast dimensions and event sequences during the process of categorisation. In fact, the process of developing and applying this tool was integral to the analysis itself.

Representative ResearchMap displays are given in Figure 8.8, Figure 8.9 and Appendix 9 (p. 290). The record titles listed on the left summarise main ‘milestone’ events, providing a time-ordered, ‘critical incident chart’ (Miles & Huberman, 1994, p. 115). Other dimensions are plotted in chart form against this, for example, the ‘CAL’ and TutorialTools’ phases. In each column, a single bar indicates a record referring to the particular dimension; a rectangular charted area indicates a record extending over a period; and increasing pattern density indicates overlapping records. The first group of dimensions (the CAL, TutorialTools, TE, LE, Activity...
Manager, OCCA and OCCA-SS ‘Phases’) chart data associated with distinct technical and educational approaches. Some overlap is evident where projects associated with different phases ran in parallel. Dimensions of the ‘source’ property of records (diaries, documentation, email, software and journals) indicate variability in data over the nine years. ‘Milestone’ events and records that provide a useful ‘snapshot’ of the situation at a given time are also charted.

Figure 8.8  ResearchMap mapping of phases and data sources 1991–1994 against ‘milestone’ events (left)

Other ResearchMap displays associated with the ‘individual’, ‘process of reconceptualisation’, ‘organisation’, ‘technology’ and ‘curriculum’ are provided in Appendix 9 (p. 290). On each of these displays different dimensions and options were set for each column. For example, in the individual dimensions display (Appendix A9.2, p. 292), the stressed’ and ‘concerned’ dimensions are combined into one column. In another column, text from the ‘Title’ of records referring either ‘stressed’ or ‘overworked’ dimensions is listed. This capacity to explore succinct chronological maps of text and patterns, and to focus on and alter dimension categories at will, played a pivotal role within the categorisation process.

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<table>
<thead>
<tr>
<th>Year</th>
<th>Event Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1996</td>
<td>Enrolled in PhD at La Trobe</td>
</tr>
<tr>
<td>1996</td>
<td>Tutorial Engines over to TRU</td>
</tr>
<tr>
<td>1996</td>
<td>Enrolled in PhD at La Trobe</td>
</tr>
<tr>
<td>1996</td>
<td>Enrolled in PhD at La Trobe</td>
</tr>
<tr>
<td>1997</td>
<td>First thinking about ID in X11M</td>
</tr>
<tr>
<td>1997</td>
<td>LE - VA script collaboration agreement</td>
</tr>
<tr>
<td>1997</td>
<td>Start of Physiology Web project</td>
</tr>
<tr>
<td>1997</td>
<td>ASCLITE 96 conference</td>
</tr>
<tr>
<td>1998</td>
<td>Programme starts work on LE programming</td>
</tr>
<tr>
<td>1998</td>
<td>Development of open-ended test and graph examples</td>
</tr>
<tr>
<td>1998</td>
<td>Formal agreement to dev. VA-LE reached</td>
</tr>
<tr>
<td>1998</td>
<td>Emergent works begins moving LE object to X11M</td>
</tr>
<tr>
<td>1998</td>
<td>Early outline of Tutorial Engines concept</td>
</tr>
<tr>
<td>1998</td>
<td>Web comp. framework proposed to Chem.</td>
</tr>
<tr>
<td>1999</td>
<td>First UML object in X11M using DDS</td>
</tr>
<tr>
<td>1999</td>
<td>UML object in X11M using DDS</td>
</tr>
<tr>
<td>1999</td>
<td>UML object in X11M using DDS</td>
</tr>
<tr>
<td>2000</td>
<td>First UML object in X11M using DDS</td>
</tr>
<tr>
<td>2000</td>
<td>UML object in X11M using DDS</td>
</tr>
<tr>
<td>2000</td>
<td>UML object in X11M using DDS</td>
</tr>
</tbody>
</table>

Figure 8.9  ResearchMap mapping of phases and data sources 1996–2000 against "milestone" events (left)
**Statistical representation of data**

A third approach to visualisation of data uses a statistical approach to map the relationships between the properties and dimensions as statistical charts and correlation tables (C5 in Table 8.3). This aspect of the analysis is detailed in Chapter 12.

### 8.4.6 D. Description through narrative history

The fourth strand of the grounded research analysis employs stories as means of representing the complexity of data associated with an extended human experience (Column D in Table 8.3). Such ‘narrativising’ is an interpretive process through which sense can be made of human experiences, actions and intentions in the course of events (Davidson, 1997, p. 124). It draws on “ordinary vocabulary to convey ideas about things, people and places” (Strauss & Corbin, 1998, pp. 16-18). A narrative cannot be a fully objective account, as the descriptive details are chosen by the storyteller to convey a sense of believability and to arouse feelings, maintain interest, convince or otherwise persuade a reader. It may also contain moral judgements. Such descriptive data embodies rich conceptual ideas about the situation and can provide the basis for, and is validated by, further interpretations of data and development of theory.

In this analysis, the case study narrative:

- is part of the meaning making process of analysis;
- provides a form of evidence that maintains rich detail and a sense of ‘reality’; and
- provides secondary data in its own right, to be analysed in later stages of the study.

Thus, the process of writing the narrative history (D2–3 in Table 8.3) is an integral aspect of whole grounded analysis framework, occurring in concert with data collection and reduction (A2–3), categorisation (B2–3) and visual representation (C2–3). Each strand of the analysis contributes a unique perspective and in turn undergoes reconceptualisation in the light of understandings gained from the other investigative strands. The narrative history also serves to bracket the statistical data analysis (E5) by verifying and explaining relationships revealed. While acknowledging the inherent bias, the history has been used as a means of eliciting alternative perspectives on the development experience from other stakeholders in Section 11.4 (D5).

As a chronological account of events and personal perspectives, the history was directly generated from the summary database listings (Figure 8.). Turning this raw sequence of data into readable form, while maintaining detail and sense of ‘reality’ required compromise and balance. My approach was to study each item in the listing using a grounded approach and ask:

- what is happening here?
- how does item this relate to previous or future events?
- is this just an isolated phenomena, or is this part of a storyline?
- can this be grouped with adjacent items to expand a theme? and
- is the chronological placement of this item critical to its meaning?
I often had to re-visit original sources for additional evidence and to further refine, create and/or re-categorise record items. The writing was re-drafted several times in the light of feedback to improve readability. The following factors outline the scope and limitations inherent in the descriptive narrative.

**Perspective** – the narrative account is seen from my perspective, drawn primarily from my personal record of events and interpretation of evidence, augmented by feedback from key participants in stages four and six of the grounded analysis (Table 8.3).

**Audience and focus** – the meaning revealed within the narrative will depend on the background and experience of the reader. For example, some may follow the technical ‘story-line’, while others will not. In crafting the story, I have tried to balance technical, pedagogical, personal and organisational perspectives, but recognise that others will foreground certain aspects and background others.

**Collaboration** – over the course of the developments, I collaborated formally and informally with numerous teaching academics and colleagues, who contributed many ideas feeding into the evolving product. Some indication of these associations is given within the narrative, but more specific acknowledgement is provided within some 34 published papers (Section 7.7.4).

**Level of detail and objectivity** – the data summarised within the database (over 120,000 words) must be acknowledged as the product of the subjective selection and treatment processes. This was influenced by consideration of the possible impact on others and my perceptions of what was important. For example, what influence did ‘family life’ have on the development and vice versa? For understandable reasons these considerations were downplayed in the data gathering and the narrative stages, although they did emerge in later reflections on the story by others (Section 11.4). Likewise, the representation of full details of workplace situations in any real life study must be considered against ethical obligations, so that a fully objective account can never be achievable.

Given all these compromises, the question might be asked: can such an account make a genuine contribution to the study? I would argue strongly that with certain qualifications it can, for the following reasons.

**Perceptions rather than objective fact:**

The story should be seen as a rendition of *my* perceptions of a complex history, rather than an attempt to portray a general truth. This point is fundamental to the constructivist philosophy of this study. The representation of my perception of events is, without question, an interpretation of a system of which I am a part.

**Derived from a systematic process:**

The story was generated by a systematic process. My contemporary reflections on events and other data available to me were systematically collated and categorised according to established grounded theory methodology into a raw chronological record, from which the story was précised into a pragmatic rendition. Finally, refinements were incorporated following feedback from others.
Contribution to the analysis:
Story writing is an important strand of the whole grounded analysis process, bracketing the categorisation, visual displays and statistical analysis of data (Section 7.3). Moreover, the story provides a unique form of rich data, accessible to other researchers or teachers who will be able to analyse or supplement these two case histories from other perspectives and settings.

Relevance:
Within higher education, there are countless people engaged in countless innovative developments, each with their own unique stories. Despite the contextual variation, there are many persistent issues, such as project failure, workload and change that are critical to our understanding, but rarely voiced in any detail. By attempting to lay such issues ‘on the table’, I hope others will be able to compare and contrast this representation with their own experiences and that these can be discussed in a wider forum.

Research into the role of storytelling in organisational sense making and problem solving suggests that the process of ‘narrativising experience’ is fundamental to organisational learning and innovation in knowledge-intensive firms (Davidson, 1997, p. 124). However,

…little attention has yet been given to the role and function of narratives in organizational efforts to develop, implement, and apply information technology. Yet these complex social activities…require the kind of sense making and social negotiations which narrativizing experience enables.

(Davidson, 1997, p. 125)

I believe that the use of personal narratives offers a practical way to represent and inform organisational practice. The alternative is to ignore real world complexity and continue to put faith in idealised models and theories that, while appearing to offer a logical way forward, often fail to acknowledge even self-evident factors, such as workload or stress, that directly impact on educational initiatives.

One method of employing such institutional stories is as a basis for discussion with other stakeholders. Given that the analysis has focused so far largely on the developer experience, the narrative provided a unique means to elicit alternative perspectives on the development history (D5 in Table 8.3). The relative readability, rich localised detail, narrative form and ‘honesty’ of the narrative provided a means to engage a variety of individuals with different interests in the innovation process.

A range of participants, representing teachers, colleagues, managers, family and others were invited to read the account and later, to be interviewed. The interviews were informal, allowing issues, related situations and personal perspectives to emerge, which I recorded in note form and later organised by stakeholder categories in Section 11.4. Participants were specifically asked to suggest any aspects of the narrative history they felt needed to be amended and had the opportunity to review the narrative and interpretation of perspectives. These alternative perspectives influenced in turn the creation of the organisational model in Chapter 13 as shown in Figure 8.3.
8.4.7 E. Integrative analysis

In the final strand of grounded analysis for Goal 2, the emerging categories, visualisations and narratives were drawn together to explain effects and look for relationships between phenomena (Table 8.3, E4–5). Strauss and Corbin refer to this process as ‘theorizing’, which follows ‘description’ and ‘conceptual ordering’ (Strauss & Corbin, 1998, p. 21). Theorising involves conceiving ideas and formulating them into a “logical, systematic, and explanatory scheme”. In developing an idea into a theory, it is necessary for it to be explored from many different angles, checked against incoming data and amended as necessary. A theory goes beyond description and should enable users to “explain and predict events, thereby providing guides to action.” (Strauss & Corbin, 1998, p. 25).

Miles and Huberman, refer to this phase of qualitative research as “conclusion drawing/verification” (Miles & Huberman, 1994, p. 11). This activity is interwoven with data collection, reduction and display, with the researcher continually searching for irregularities, patterns, possible configurations, causal flows or explanatory propositions.

In the integrative analysis of this study, the emerging meanings were tested for their plausibility by:

- integrating the perspectives from different research strands; and
- comparing and contrasting the two case studies.

The components of the integrative analysis are indicated within Figure 8.3. This began with a reflection on the raw phenomena emerging from the categorisation of data in Section 8.4.4B. These properties and dimensions were re-organised through a holistic consideration of the evidence to form a new ‘Classification Framework’ of 32 dimensions for the workplace experience (Section 12.2.1). This Framework provided the basis of a statistical analysis examining the distributions and correlations of variables.

While such statistical evidence alone is insufficient to prove causal relationships (Heiman, 1998, p. 243), implied links may be further explained by reference to other representations. The workplace experience was therefore systematically de-constructed in Section 12.3 using both the statistical and narrative evidence (Figure 8.3). Possible relationships were investigated for confirming or dis-confirming evidence by examining:

- variation across the phases or case studies;
- exemplar vignettes within the narratives;
- patterns within the visualisations; and
- further re-examination of the research database records, or even source data.

In the final stage of the grounded analysis, the deconstructed workplace experience was formed into a relational model from the perspective of the developer, representing participants and activities in the process of innovation, derived from empirical evidence (Section 12.4).

The statistical analysis will be outlined in more detail in Chapter 12.
8.5 Collaborative Developmental Research model: Goal 3

The third goal of the study was to build on the experience of collaborative project work within the University and the analysis of workplace understanding to establish a practical organisational model for research and development of generic CFL learning systems (Section 2.3.3). This model reflects the assumption that the research process must accommodate the fundamentally different perspectives of developer and teacher, which are best elicited through collaborative activity. The partnership model, which I have called ‘Collaborative Developmental Research’ (CDR), is intended to provide a practical guide for understanding the process of innovation from an organisational perspective. The approach used in this aspect of the study draws on the Mixed-Methods methodology, outlined in Section 7.6.

8.5.1 Data collection and analysis

The development of an organisational model represents an additional theory development stage building on (Figure 8.3):

- the deconstructed representation of the workplace experience of CFL development (Section 12.3);
- the developer-focused model of innovation (Section 12.4, Figure 12.9);
- the alternative perspectives of organisational stakeholders (Section 11.4); and
- one particular case study in curriculum collaboration – the ‘Group Project’ in Physiology (Section 10.2).

This evidence encompasses the generic CFL systems development and associated curriculum projects (Goal 1) and a comprehensive analysis of the workplace development experience (Goal 2). This third goal now focuses on the organisational character of the innovative development process. By re-examining the emerging evidence from the perspective of the organisation, rather than that of the product or developer, the basis of an organisational model of innovation can be synthesised.

There are two contrasting aspects to this component of the study reflecting the adoption of the Mixed-Methods methodology: re-analysis of the emerging grounded theory (Section 13.2); and a case study of collaborative action research taken from one particular curriculum project involvement (Section 13.3).

8.5.2 CDR model

In final development of an organisational model of the CDR process, the collaborative research case study and findings emerging in Chapters 11 and 12, were ‘re-viewed’ through an organisational ‘lens’. That is, by re-examining evidence from an outsider’s, rather than developer’s, perspective, an alternative ‘organisational’ representation of the innovation process was created. For each aspect of the original model, I asked:

- would this phenomenon be of interest to others (managers, colleagues, teachers, etc.)?
- how would this be perceived by others not familiar with the innovation process?
- can this be illustrated with an example from the narrative history or a case study?
- how can this be described in plain English terms? and
- how can this ‘innovator’ knowledge be made of value to others?

The scope of data used in the development of the CDR model is summarised in Table 8.5.
Table 8.5  Data sources employed in the analysis of the Collaborative Developmental Research model

<table>
<thead>
<tr>
<th>Data</th>
<th>Role in CDR organisational model analysis</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Narrative history</td>
<td>Evidence for CDR model analysis; cross-references to characteristic events.</td>
<td>Sections 11.2, 11.3.</td>
</tr>
<tr>
<td>Alternative perspectives of</td>
<td>Understanding of other perspectives that may be present within the organisation.</td>
<td>Section 11.4.</td>
</tr>
<tr>
<td>individuals</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CFL systems innovation model</td>
<td>Evidence for CDR model analysis in Section 13.2, indicating the participant community and nature of interactions observed over the entire study period.</td>
<td>Grounded analysis in Section 12.3.</td>
</tr>
<tr>
<td>‘Group Project’ reflective</td>
<td>Personal records of day-to-day events, observations and reflections.</td>
<td>Journals maintained by participants (Section 13.3.1).</td>
</tr>
<tr>
<td>journals</td>
<td></td>
<td></td>
</tr>
<tr>
<td>‘Group Project’ publications</td>
<td>Assisting in reflection, articulation of model and formal documentation of the collaborative experience.</td>
<td>(Fritze, Kavnoudias et al., 2001b; Kavnoudias et al., 2000; Kemm, Williams, Kavnoudias &amp; Fritze, 2001; Kemm, Williams, Kavnoudias, Fritze et al., 2001)</td>
</tr>
<tr>
<td>‘Group Project’ participant</td>
<td>Regular project discussions: practical problems attended to and reflections on process.</td>
<td>Documents and journal notes (incorporated into the research database).</td>
</tr>
<tr>
<td>meetings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>External meetings</td>
<td>Teaching staff from other faculties using OCCA in different curriculum projects.</td>
<td>Documents and journal notes (incorporated into the research database).</td>
</tr>
</tbody>
</table>

8.5.3 Collaborative action research case study

The above organisational analysis builds in particular from one particular curriculum project as an action research case study – the ‘Group Project’. This was undertaken in collaboration with Physiology teachers between January and August 2000. The educational design behind this involved students working in groups on a semester-long topical problem within a Collaborative Learning Environment. The Group Project was described as an educational case study in Section 10.2, but in the context of the third goal, is treated as a case study of CDR, occurring in parallel with, and integral to, the organisational analysis. This particular case study was selected because of its critical contribution to the generic system development, the long-term association of the teachers with the innovation process and the particularly constructive nature of the collaboration established.

The ‘Group Project’ represented the first implementation of the final version of the generic online system (Section 9.3). As a formal collaboration, the project had the specific intention of developing a working curriculum module, refining the generic system and increasing understanding of educational and developmental processes (Kavnoudias et al., 2000, p. 98). Action research methods outlined in Section 8.3 apply here also, but the methods are specified in more detail with Section 13.3, where it is treated as an exemplar of the CDR process itself. The primary data used within the action research process included reflective journals that were maintained by the teachers and me over the period of the development. Records of meetings involving lecturers, tutors and students were also used. It is worth drawing attention to the process of academic publication as a means of facilitating reflection within the action research cycle.
8.6 Summary

In this chapter, the methods and data used for the three goals of the study were described. There are two main periods examined in the research: the main CFL systems development occurring between 1999 and 2000; and an additional case study between 1991 and 1994.

The research method for Goal 1 of the study followed an action research prototyping approach in the production of a generic online learning system. Pivotal to this were opportunities for me to consult and collaborate with teachers on curriculum projects, which primarily originated from University funding programs for curriculum innovation. There were two parallel purposes for this activity: a generic software development and individual curriculum project outcomes. Thus, contrasting interpretations of the action research method were required to reflect the multiple perspectives of the developer and teachers. These revealed differences in the manner of initiation of the project, its goals, structure, authority, process model and degree of formalisation. The difficulty of engaging teachers and academic funding bodies with the notion of an action research approach required a pragmatic interpretation of the process. The focus of the action research was therefore generally on the developer, with low-key involvement of teachers.

Goal 2 aimed to increase understanding of the development experience and used a grounded analysis approach focused on the two development case studies spanning the periods 1991–1994 and 1996–2000. A specially designed research database was developed to manage the significant body of data coming from multiple sources. Record items were categorised into raw properties and dimensions in an iterative process and continued across much of the study, as understanding progressively developed. The emerging picture of the development experience was enriched through multiple representations of the data in chronological listings, visual maps of dimensions, the narrative history of the events and statistical reviews.

The research method for Goal 3 used a Mixed-Methods approach. Firstly, evidence from the developer’s perspective of the innovation was re-examined through an organisational lens to provide a model of an innovative development process relevant to those outside the process. Secondly, action research activity within a particular curriculum project provided a means of investigating the process of developer-teacher collaboration, as well as an exemplar case study of a process of Collaborative Developmental Research.

This chapter concludes the background and research design of the study. The following chapters now can reveal the outcomes of the research, organised according to the three goals. Outcomes of Goal 1 are firstly reported as a generic software product (Chapter 9) and as particular curriculum implementations of the system (Chapter 10).
CHAPTER 9. OCCA: a generic online learning system

9.1 Introduction
This chapter is the first of two examining the software production outcomes of the first goal of this study: to produce a generic online software system to facilitate innovative learning and teaching. Here the software product is examined from three perspectives (Figure 8.3, p. 107):

- the evolution in its aims and development through a series of distinct phases (Section 9.2);
- the structure and key features of the ‘final’ product, the Online Courseware Component Architecture (OCCA) (Section 9.3); and
- the capacity of the system to support quality learning and teaching (Section 9.4).

The software production outcomes are further examined in the next chapter, which turns attention to the use and evaluation of the software within implemented curriculum projects.

9.2 The evolution of a software product
The production of the generic CFL system in the context of this action research inquiry occurred over a period of four years from 1996, although aspects of the development occurred prior to this and continued after completion.
of the study. Given the nature of the action research prototyping methodology described in Chapter 8, it is not unexpected that the nature and technical design of the product evolved substantially. The evolutionary aspect of the software production is examined here in terms of key production phases associated with distinct technical and educational strategies. These production phases form an important cross-referencing framework used throughout the following chapters.

9.2.1 Principal phases of the software development

Seven primary phases in the software development emerged from the grounded analysis of the development experience in Chapter 12. They are introduced at this point as a unifying framework that will link aspects of the inquiry across the following chapters. The phases refer to particular periods of development generally associated with certain software design approaches after which they are named. A detailed chronology of this progression is provided in the narrative history in Chapter 11. It is of note that the action research component of the study is pre-dated by related software developments and continues past the formal action research period. That is, the study is set within the wider professional context revealed in the analysis.

The origins of the generic system development can be traced back to a series of interactive HyperCard¹ tutorials I produced for the Chemistry Department in 1991 (the ‘CAL’ phase in Table 9.1). This interactive functionality was amalgamated into a single ‘TutorialTools’ authoring application (Appendix 3, p. 275), which actually provided the first iteration of the generic software system development in 1996 in the action research study (the ‘TutorialEngines’ phase). The original instructional model evolved into a more complex and flexible tool in the later ‘Learning Engines’ and ‘Activity Manager’ phases, which used interactive ‘Shockwave²’ objects running in Web pages. The final phase within the action research study describes the development of the ‘Online Courseware Component Architecture’ (OCCA Client-side). At this stage, dependency on interactive objects was removed and a central database introduced. The conceptual design had made a profound shift from a highly interactive learning ‘engine’, to a low-level architecture for managing learning transactions across Web pages.

The final ‘OCCA Server-side’ phase in Table 9.1 marked the conclusion of the action research in late 2000, when software functions were shifted to the central server by staff of the Central Unit (see Section 11.3.5). The difference between the ‘Client-’ and ‘Server-side’ OCCA models was technical, rather than functional, and within the study, I refer to ‘OCCA’ in the generic sense, unless the distinction is relevant to the discussion.

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¹ HyperCard: an early authoring application produced by Apple Computers.
² Shockwave: technology for creating interactive software objects that run within Web pages.
Table 9.1  Phases of software production activity

<table>
<thead>
<tr>
<th>Phase</th>
<th>Description</th>
<th>Narrative history</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TutorialTools Production of a generic HyperCard authoring and delivery application based on the CAL tutorials (Fritze, 1993; Fritze &amp; McNaught, 1994).</td>
<td>11.2.2</td>
<td>Description (Appendix 3, p. 275).</td>
</tr>
<tr>
<td>2. Action research prototyping 1996–2000</td>
<td>Tutorial Engines TutorialTools functionality translated into an online interactive ‘Shockwave’ Quiz object running in a Web page (Fritze, 1996b).</td>
<td>11.3.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Learning Engines Quiz object expanded into toolkit of educational elements dynamically assembled on a Web page according to an authoring ‘script’ (Fritze &amp; Ip, 1998; Fritze et al., 1998; Fritze &amp; McTigue, 1997).</td>
<td>11.3.2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Activity Manager Master object in browser dynamically creates interactive pages providing an extended student activity defined by an authoring script.</td>
<td>11.3.3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>OCCA Client-side Independent Web pages containing specialised functions to save and recall data in a central database (Fritze &amp; Kemm, 2000; Fritze et al., 2000; Fritze, Kavnoudias et al., 2001b).</td>
<td>11.3.4</td>
<td>Description (9.3), case study (10.2).</td>
</tr>
<tr>
<td>3. Continued development August 2000–present</td>
<td>OCCA Server-side Core OCCA functionality relocated to central server, maintaining same educational features. Continuing development continued by Central Unit staff (Fritze, 2001).</td>
<td>11.3.5</td>
<td>Description (9.3), case study (10.3).</td>
</tr>
</tbody>
</table>

9.2.2 Evolution of production aims and descriptions

To establish the connection between the development phases, I have analysed contemporary descriptions of the software made in reports to management, user documentation and conference papers uncovered in the process of data collection (Appendix 5, p. 283). This provides an audit trail of the research purposes across the study. Six key design themes emerged from the analysis of these data that were consistent across the phases of software development:

- rich, customisable learning activities;
- provision of views of student learning;
- accessibility to teachers;
- building a community of users;
- a modular, reusable structure;
- use of standardised protocols; and
- building on previous developments.

Key technical and educational features of the products associated with these different themes are summarised in Table 9.2. Despite the apparent consistency in these aims and visions, significant variations in the technical implementation and educational models are revealed across the development phases, indicated by the changing
nature of the product from ‘object’, ‘object toolkit’, ‘Web controller’ to ‘architecture’. The significance of this conceptual design evolution across the phases of development is discussed below under each theme.

### Table 9.2 Summary of aims and descriptions derived from documented descriptions of different phases

<table>
<thead>
<tr>
<th>Phase</th>
<th>TutorialTools (TT)</th>
<th>Tutorial Engines (TE)</th>
<th>Learning Engines (LE)</th>
<th>Activity Manager (AM)</th>
<th>OCCA (client- and server-side)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design theme</td>
<td>‘application’</td>
<td>‘object’</td>
<td>‘object toolkit’</td>
<td>‘Web controller’</td>
<td>‘architecture’</td>
</tr>
<tr>
<td>2. Providing views of student learning</td>
<td>Logs of student answers, times spent.</td>
<td>None implemented.</td>
<td>None implemented.</td>
<td>Short term history and progress maps maintained for students only.</td>
<td>Optimised views of any work for both students and teachers. Reflection.</td>
</tr>
<tr>
<td>3. Accessibility by teachers</td>
<td>Tool for generating and editing questions.</td>
<td>Configurable objects assembled in Web pages controlled by question scripts.</td>
<td>None implemented.</td>
<td>Web page construction – supported by resources and Central Unit.</td>
<td></td>
</tr>
<tr>
<td>4. Building a community of users</td>
<td>Adopted across single department and similar disciplines in other universities.</td>
<td>Potential market for sharing interface objects, activity styles.</td>
<td>None implemented.</td>
<td>Centralised learning system, departmental learning designs.</td>
<td></td>
</tr>
</tbody>
</table>

### 1. Rich, customisable learning activities

My interpretation of ‘rich and customisable learning activities’ varied significantly over time. For example, the TutorialTools ‘application’ used a number of in-built question styles and provided multiple levels of immediate feedback to students. A similar interaction style was used in both the online Tutorial Engines and Learning Engines Web ‘objects’, which could be extended with additional discipline-specific interactive interfaces. The Activity Manager phase extended learning interactions to include complex sequences of ‘activities’ and to maintain a history of student actions to support reflection by students.

To this point, the product designs were somewhat ‘teacher-centred’, in that the teacher pre-configured activities and pre-emptive feedback that would engage students. In the OCCA phases, the vision is of a more fundamental Web architecture, empowering teachers to construct more open-ended and discursive learning transactions. These may involve both students and teachers in, for example, articulation, reflection and re-articulation activities that carry across an entire course.
2. Views of student’s learning experience

The notion of a rich teaching environment to provide views of the students’ learning experiences complements that of a rich learning environment. This was implemented to varying degrees within the phases. In TutorialTools, pre-defined, but comprehensive, reports of correct and incorrect answers and students comments, provided an important link in the course feedback cycle (Fritze & McNaught, 1994, pp. 864-5). Teacher reports of students’ experiences were described in later phases, but not fully implemented until the OCCA database was introduced. This phase marks a profoundly different approach to reporting, as it enables teachers to craft views of student work optimised for their particular discipline requirements. Moreover, these views are equally relevant to teachers and students and could be shared within a group or between students. Evaluation feedback can be integrated within OCCA learning activities and displayed as optimised summaries to facilitate effective learning and teaching.

3. Accessibility by teachers

The possibility for teachers to create their own teaching materials was a consistent requirement. It was represented initially by the concept of ‘authoring tools’ and the ‘scripting’ of questions by teachers, but later focused on support from the Central Unit or the provision of re-usable resources, such as customised ‘templates’ and ‘library items’. There was a change from the single discipline focus of TutorialTools, to a centralised model encouraging self-sufficiency and content development across all departments. This required the Central Unit to provide ‘training and support’, ‘examples of good practice’, as well as standardised tools running on centralised systems. Teachers using the OCCA system were able to create their own activities as Web pages using simple Web page editors.

4. Building a community of users

This theme sees the educational software as a key facilitator of user activities, for example, through opportunities for collaborative development, or the sharing of content. Although TutorialTools was developed for use in a single departmental, it was adopted within a number of Chemistry departments in other Australian universities. The desirability for “opportunities to share, or further develop, learning and management components across different disciplines” remained a stated objective, although most use remained within the immediate curriculum projects. A significant expansion in user communities occurred when other staff of the Central Unit adopted OCCA in other curriculum projects, which furthered development of the software and provided centralised support to faculties.

5. Modular, reusable structure

The theme of modular structure and the reuse of materials was common across the phases, although again, how this was achieved varied significantly. Modularity and reuse can be examined from both technical and pedagogical perspectives.

Firstly, technical modularity and reuse focused on a need to optimise programming effort and the reuse of software code. This is fundamentally related to the software technical structure but directly impacts on users. For example, TutorialTools was a high level authoring ‘application’ enabling teachers to create packaged Chemistry
tutorial programs that could be installed on individual computers. Technical modularity in Tutorial Engines centred on a single quiz ‘object’ embedded in different Web pages. Further modularity was obtained by connecting this with other objects, for example, a periodic table object could be added as a user interface to the basic quiz question (Feb 1997 in Chapter 11). Modularity within Learning Engines had an entirely different meaning. The object itself was constructed out of smaller internal components to form highly flexible configurations of quiz questions or interface objects, such as the Graph Sketcher (Fritze & Ip, 1998; Kennedy & Fritze, 1998). In effect, the Learning Engine object had become a specialised ‘browser’ running within a Web page. Teachers could assemble such an object for particular learning interactions, while programmers could easily create additional internal sub-objects for new learning requirements. While the Web itself is highly modular in terms of static resources, the vision behind Learning Engines was to produce an equivalent framework for highly interactive learning components. In the Activity Manager phase, the nature of modularity shifted to Web pages, under the control of a single reusable ‘manager’ object. Technical modularity within OCCA lies primarily in a highly centralised learning system supporting all users. In addition, Web page components constructed in HTML, JavaScript, Java, Flash or Shockwave can be shared and reused by others. This aligns with the notion of modularity and reuse within the Web itself.

Pedagogical modularity and reuse on the other hand, focuses on the capacity of the software to facilitate the packaging and re-use of educational content, or teaching techniques. For example, TutorialTools had the facility to export and import question content between tutorials. The strength of the instructional model also enabled the School of Chemistry to transfer a substantial body of content generated in this system to an online equivalent (Coller & Tregloan, 2001, p. 15). Pedagogical modularity within OCCA focuses on dynamic Web page designs that can be readily shared and exchanged. Even more significant is the ability to share conceptions of educational functionality, such as ‘student learning portfolios’, ‘reflective questions’ or electronic’ annotation’ of student work’. Such modularity can be thought of as actual Web pages to be duplicated, re-usable technical designs or simply useful teaching techniques. These represent important avenues for facilitating efficient diffusion of good practice at different levels.

Because the OCCA architecture deals primarily with low level learning transactions, it is able to underpin both technical and pedagogical reusable structures, which might be in the form of elements on a page, activity pages or even a whole course site.

6. Standardised protocols

The requirement for ‘standardised protocols’ emerging across the product descriptions parallels that of technical modularity and reusability. Two distinct protocol forms are apparent:

- scripting of various forms used to configure software objects in all phases prior to OCCA; and
- a content description protocol for representing ‘work’ undertaken by users, first introduced in the Activity Manager.

The ‘question script’ in TutorialTools (Dec 1992 Chapter 11) turned an ‘empty’ TutorialTools application into a functioning tutorial. This took the form of plain English statements describing the question ‘type’, ‘assessment criteria’, ‘hints’ and ‘explanations’. It provided a means of authoring for non-technical users, while for the
programmer, new functionality could be added simply by updating the vocabulary, rather having to refine the authoring interface.

During the Learning Engines phase, a standardised means for describing the ‘state’ of an object emerged (Aug 1998 Chapter 11). This was further developed in the Activity Manager using XML as a means of transferring information to and from Web pages and specifying activity sequences and feedback. In OCCA the entire notion of master control and content specification was dropped entirely, but the ‘State Description Protocol’ became the key feature of the OCCA database model for recording and displaying work by both students and teachers. The evolution of scripting and protocols is illustrated in Figure 9.2.

<table>
<thead>
<tr>
<th>Development phase</th>
<th>Scripting protocol</th>
<th>Content description protocol</th>
<th>Context</th>
</tr>
</thead>
<tbody>
<tr>
<td>TutorialTools</td>
<td>‘Question Script’</td>
<td></td>
<td>Tutorial Program</td>
</tr>
<tr>
<td>Tutorial Engines</td>
<td>‘IO Script’</td>
<td></td>
<td>Quiz object</td>
</tr>
<tr>
<td>Learning Engines</td>
<td>‘LE Script’</td>
<td></td>
<td>Components of the LE object</td>
</tr>
<tr>
<td>Activity Manager</td>
<td>‘LE script’</td>
<td>State Description Protocol</td>
<td>Sequences of Web pages/objects/components &amp; their ‘states’</td>
</tr>
<tr>
<td></td>
<td>(XML)</td>
<td>State Description Protocol</td>
<td></td>
</tr>
<tr>
<td>OCCA (client/server)</td>
<td></td>
<td>State Description Protocol</td>
<td>Transaction of ‘work’ between students, teachers &amp; database</td>
</tr>
</tbody>
</table>

*Figure 9.2 Evolution of scripting and content description protocols across the phases of development*

7. Building on previous experience

The final theme emerging from the software descriptions reflects the way in which designs were iteratively developed from the experience of previous prototypes. Two forms of iterative transfer were apparent: functional and technical.

Firstly, concepts or functional designs from previous versions could be incorporated into new software, for example, the TutorialTools instructional model was adopted for the Tutorial Engines online quiz object.

Secondly, the previous technical software structures could be refined to accommodate new understandings. For example, the code in the ‘handcrafted’ tutorial programs from the CAL phase was gradually transformed into the TutorialTools authoring application.

It should be pointed out that, although the major design phases provide a useful framework for discussion, there are in practice innumerable iterations in pedagogical and technical design. The time scale of these can be literally minutes, as a function is coded and tested; weeks, during trials of a course; or years, when an application, such as TutorialTools, is redeveloped in a new context. The idea of iterative development is also outlined in the action research prototyping methodology (Section 8.3).

---

3 XML: an object-orientated document protocol similar to but more sophisticated than HTML in Web pages.
The above seven ‘design’ themes emerging from descriptions of the software development complement the narrative history of Chapter 11 and the more detailed grounded analysis of the workplace experience in Chapter 12. They illustrate the ongoing professional process of learning and adaptation of strategy, underpinned by a consistent underlying vision encompassed by the themes.

9.3 OCCA: Online Courseware Component Architecture

The principal software production outcome is reflected in the characteristics of the ‘final’ version of the generic learning and teaching system. The functional specifications here refer to the most recent server-side implementation of the OCCA system software, re-engineered by staff of the Central Unit. The educational functionality of the client- and server-side versions are, however, essentially identical. For example, the curriculum projects discussed in Section 10.2 and Section 10.3 were implemented in the different versions, but this has no bearing on the nature of the student experience and educational intentions of the teachers.

In describing the OCCA system, I must emphasise that this product has depended on the constant input and ideas of academic staff collaborating in curriculum projects and colleagues in the Central Unit. In particular, Gangmeng Ji was responsible for all database and server programming up to the end of 2000 and provided significant creative input to the systems design (Fritze et al., 2000). Additional contributions are noted within the narrative history and in published papers (Section 7.7.4).

9.3.1 Overview of OCCA

OCCA can most simply be described as a Web server, supported by a database with additional functions for managing learning and teaching ‘transactions’. Such transactions involve ‘work’ of an arbitrary nature undertaken by a student or teacher that is either saved in the database or recalled into Web pages. OCCA can be distinguished from regular Web servers and learning management systems, such as WebCT, by certain fundamental properties:

- there are no predefined structures for either learning or teaching activities;
- course structures and user interfaces are defined entirely by Web pages created by course designers;
- no technical distinction is made between students or teachers in terms of the ‘work’ they undertake and information they generate, which is recorded in standardised form in a central database;
- the primary interface to learning and teaching is through individual Web pages, used to record and display work of students, teachers or groups of individuals; and
- interactive online objects may also be used to contribute and retrieve information using the standardised protocol.

An OCCA Web site therefore has no fixed structure or high-level pedagogical functionality of the type that typifies commercial learning management systems, such as WebCT or TopClass. Although it is possible to set up rich learning activities and interactions between users, there are no predefined question formats, course structures, communication mechanisms or teaching tools. Indeed, the only common tools provided are rudimentary functions for administering users and groups (Appendix A4.4, p. 280).
Learning, teaching and higher level administration activities are all created through the design of Web pages, reflecting specific course requirements. It is a fundamental design feature that no technical distinction is made between students, tutors, teachers or indeed, any other potential roles. All users are assumed to make equivalent transactions, either contributing information to the database, or reviewing such information at a later stage. Naturally enough, students and teachers are likely to undertake different tasks and require different views of student learning, however, this difference should not simply be assumed. For example, a summary of students’ responses to a question, or evaluative student feedback may indeed be just as valuable to students as the teacher. A teacher, on the other hand, may well benefit from working through student learning tasks and these ‘expert’ answers may prove useful to students.

Figure 9.3 illustrates the basic structure of the current version of OCCA. Within OCCA, information can be submitted to the database using HTML page ‘forms’, using a standard Web data transaction. There is no pre-determined role for such information and, depending on the context, this might represent a student’s response to a question, a response to an evaluation item, or a comment made by a teacher to be later read by a student. It is a key feature of OCCA that all such data is stored within the database in a standardised form using the ‘State Description Protocol’ (Fritze & Kemm, 2000, p. 7.7). As the structure of this information is entirely open-ended, a Web page may contain any arrangement of input elements, such as text boxes, popup menus or check boxes. That is, rather than having to predefine a database record structure for every possible form of activity, OCCA simply records ‘snapshots’ of different pages in a standard format.

![Diagram of OCCA structure](image)

*Figure 9.3  Fundamental structure of the most recent version of the OCCA online learning system*

Of course such stored information is only useful if it can be recalled. Before any OCCA Web page is delivered by the server to a user, therefore, it is checked for special ‘embed tags’, which are replaced with the information requested. That is, information from text boxes, checkboxes or popup menus submitted from one page can effectively be ‘embedded’ into any other page, depending on the tags inserted by the teacher. In addition to information submitted from pages containing HTML forms, interactive objects written in Java, Shockwave or Flash are able to store and retrieve state descriptions in the same manner, for example, equipment simulations or discipline interface tools.
Using these basic transactions of information in an online environment, it is possible to build a complete course site from combinations of Web pages, providing discursive learning and teaching activities that are simply not possible using more ‘highly featured’ courseware systems. In addition to student tasks, such a site would contain pages that enable the teacher to examine students’ work, provide feedback and define content information for use within optimised learning activities.

### 9.3.2 Structural features of OCCA

The nature of courseware designs and learning transactions that can be achieved are ultimately shaped by the underlying structural features of the system – and of course the creativity of the designer! An overview only of the main structural elements of OCCA is provided in Table 9.3, with a more complete technical documentation provided in Appendix 4 (p. 278).

#### Table 9.3 Summary of key structural features of the OCCA technical functions

<table>
<thead>
<tr>
<th>Feature</th>
<th>Technical description</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standardised description of work: the State Description Protocol</td>
<td>The ability to save a ‘snapshot’ of Web pages containing any combination of input elements or even conforming interactive objects.</td>
<td>A4.2 (p. 278)</td>
</tr>
<tr>
<td>Embed tags used within Web pages</td>
<td>The primary mechanism by which information is retrieved from the OCCA. Tags inserted into any Web page are replaced with specified information from the database from the current user or group, or peer group. Other types of tag return other details, such as user name, group name or login time.</td>
<td>A4.3 (p. 279)</td>
</tr>
<tr>
<td>Inbuilt OCCA administration tools</td>
<td>The only inbuilt ‘tools’ are for administration of users, such as user’s password, group membership and access rights.</td>
<td>A4.4 (p. 280)</td>
</tr>
<tr>
<td>Extending Web page functionality with HTML and JavaScript</td>
<td>Customised layouts can be achieved using simple HTML or JavaScript on the Web page to display information from the database in specialised ways.</td>
<td>A4.5 (p. 281)</td>
</tr>
<tr>
<td>Interactive simulation and interface objects</td>
<td>Highly interactive objects created in Java, Shockwave or JavaScript can save and recall relevant state information in the OCCA database.</td>
<td>A4.6 (p. 282)</td>
</tr>
</tbody>
</table>

### 9.3.3 Examples of fundamental learning and teaching transactions

A series of simple student and teacher pages is used here to illustrate how the structural elements of OCCA can be employed within a sequence of learning activities. These examples provide the foundations for implemented curriculum activities used in the case studies of Chapter 10.

The ‘Student Input Page’ in Figure 9.4 presents a simple text-based question, with an additional popup menu for students to record their ‘degree of confidence’ and another text box to make a ‘comment’ to the teacher. When the ‘Save’ button is clicked, this information is submitted to the OCCA server, where it is saved as a database record assigned to the user. Whenever the same user revisits the page, this information is automatically restored by the OCCA server and may be edited and saved again. This is the most basic OCCA transaction.

The ‘Student Summary Page’ in Figure 9.5 uses three ‘embed tags’ to provide a summary of the ‘Student Input Page’ information. The tags are replaced by specified elements of the ‘Input Page’ record when the page is processed by the OCCA system. Naturally, other users accessing these pages would save and retrieve their own records indexed by their current user name.
The ‘Teacher’s Feedback Page’ in Figure 9.6 allows a teacher to display the responses to the Input Page by individual students and to provide feedback. The list of students is dynamically generated by a simple JavaScript function, using information from a special ‘class list’ tag. Clicking on a name will cause the page to reload with the teacher assigned as ‘proxy’ to the individual student and embed tags in the page will display the work of the student, rather than the teacher. When the ‘Update’ button is pressed, information in the text box and popup menu will be saved in another record indexed to the student’s name.

The ‘Student Review’ page in Figure 9.7 is an extension of the ‘Summary Page’ above, enabling a student to review their work (plain italics) together with feedback saved by the teacher on the ‘Teacher’s Feedback Page’ (bold italics). The ‘Rubber stamp’ image depends on the popup value set by the teacher, which specifies a particular image file. Their previous answer has been embedded in the text box and can be edited. When the student clicks ‘Save’, a new record containing the re-drafted response is created.
So far, three records have been generated from three different pages, the:

- ‘Student Input Page’ (by each individual student);
- ‘Teacher’s feedback Page’ (by the teacher, but assigned to each individual student); and
- ‘Student Review Page’ (by each individual student).

The information in these records can be collated into a single ‘Overview Page’, providing the teacher with a comprehensive history of the learning and teaching exchange of all students (Figure 9.8). This page uses embed tags and JavaScript code to create a formatted table. While clearly useful to the teacher, it could also be used by students to reflect on their learning in the context of the whole class.

![Figure 9.8](image)

**Figure 9.8** Overview of work by both student and teacher

The final example in Figure 9.9 shows how teachers can save ‘global’ information that can be inserted into other pages using appropriate embed tags. Two possible uses of this information are suggested here.

![Figure 9.9](image)

**Figure 9.9** Page used by the teacher to set information available to all students

The first textbox in Figure 9.9 is used to record the wording of the question (‘What is the capital of Australia and where is it located?’), which is displayed using a suitably addressed embed tag on the Input Page in Figure 9.4, as well as the pages in Figure 9.6 and Figure 9.8. This technique provides the foundations of an ‘online template’
enabling teachers to configure learning activities without having to edit HTML pages. The second text area might be used in an identical manner for teachers to display global messages on any other page, for example, initial instructions or general feedback offered after reviewing all the students’ work.

These constructed examples represent only the tip of the iceberg for conceptual learning and teaching structures made possible within the OCCA framework and the possibilities are, in many ways, limited only by the imagination of the designer. Other simple functions that have been created include:

- the display of conditional feedback depending on the state of a saved record, effectively providing ‘immediate feedback’ when a response is saved;
- icons that indicate a particular record has been submitted, or that a teacher’s comment has been made;
- ‘group’ pages that enable individuals to jointly submit work and to review group member contributions made in previous individual activities;
- reviews of group work by ‘peer groups’ allocated by the teacher;
- Web links or messages that only appear after a record has been submitted; or
- ‘Submit’ buttons that disappear after a record has been submitted.

In the next section, the capacities of OCCA built upon these basic structures are examined for their support of academic learning requirements.

### 9.4 OCCA support for learning and teaching requirements

The low-level nature of OCCA lays the foundations of learning activities and complete environments that can be optimised for particular discipline requirements. The examples presented in this section are drawn from implemented OCCA courses in published reports.

Before looking at the examples, it is worth emphasising that even the simplest learning transaction can underpin a rich variety of learning experiences (Fritze, Kavoudias et al., 2001b, p. 911). Consider, for example, a student or teacher submitting a short text entry from a simple OCCA page. Depending on the learning context and possible reference to other work by the student, group, peer group or teacher, different implementations of this activity might represent entirely different educational events, as indicated in Table 9.4.

**Table 9.4** Possible meaning behind the submission of a short written response by a student or teacher

<table>
<thead>
<tr>
<th>By the student:</th>
<th>By the teacher:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• a response to a question.</td>
<td>• an annotation or assessment of student work.</td>
</tr>
<tr>
<td>• a self-assessment of previous work.</td>
<td>• a response made to a student’s question.</td>
</tr>
<tr>
<td>• a review of peers’ work.</td>
<td>• a weekly ‘housekeeping’ message to all students.</td>
</tr>
<tr>
<td>• a message to a peer group.</td>
<td>• task content or configuration information (i.e., authoring).</td>
</tr>
<tr>
<td>• a question or comment to the teacher.</td>
<td>• information for tutors, or course coordinators.</td>
</tr>
<tr>
<td>• evaluative feedback to the teacher.</td>
<td>• content information for students.</td>
</tr>
<tr>
<td>• an expression of self confidence.</td>
<td>• instructions to students.</td>
</tr>
<tr>
<td>• a reflection on the learning experience.</td>
<td>• post-activity feedback to students.</td>
</tr>
<tr>
<td>• a re-drafting of earlier work.</td>
<td></td>
</tr>
<tr>
<td>• a contribution to a learning portfolio.</td>
<td></td>
</tr>
</tbody>
</table>
Thus, the quality of an OCCA learning design is likely to be more closely related to the context of the activity than to the technical functionality that underpins it. Moreover, there is overlap between the roles of student and teacher compounded by a variety of activity forms, such as learning, teaching, communication and course administration.

In the following sections, OCCA-based elements within implemented curriculum projects are mapped against the Pragmatic Educational Requirements Guide for user-active learning and teaching environments, in terms of their support for (Table 5.5, p. 59):

- the context of learning;
- the context of teaching; and
- activities necessary for user-active learning.

### 9.4.1 Supporting the context of learning

The broader context of the learning environment is an important consideration in educational systems design that underpins both formal and informal learning experiences. Both traditional and computer-supported strategies can facilitate conditions for academic learning (Table 5.5, p. 59), but the focus here is on the opportunities afforded by the OCCA system as illustrated by the examples in Table 9.5.

<table>
<thead>
<tr>
<th>Requirements</th>
<th>Implemented examples</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Learning environment</strong></td>
<td>• Work progressively stored and accessible in learning portfolios by both student and teacher (Kemm, Williams, Kavnoudias, Fritze <em>et al.</em>, 2001, p. 7.7; Margetts, 2002 #284, p. 131).</td>
</tr>
<tr>
<td>Creating conditions and opportunities for academic learning.</td>
<td>• Support for classroom-based ‘Collaborative Learning Environments’ (Kemm, Williams, Kavnoudias, Fritze <em>et al.</em>, 2001, p. 7.3, Margetts, 2002 #284, p. 130).</td>
</tr>
<tr>
<td></td>
<td>• Computer game play environment (Wallace, Jagose &amp; Gunn, 2003).</td>
</tr>
<tr>
<td></td>
<td>• Supported group work activities (Kemm, Williams, Kavnoudias, Fritze <em>et al.</em>, 2001, p. 7.5; Margetts <em>et al.</em>, 2002, p. 132).</td>
</tr>
<tr>
<td></td>
<td>• Complex learning environments, authentic activities (Wallace <em>et al.</em>, 2003).</td>
</tr>
<tr>
<td></td>
<td>• Supported interactions between peer groups (Kemm, Williams, Kavnoudias, Fritze <em>et al.</em>, 2001, p. 7.7).</td>
</tr>
<tr>
<td></td>
<td>• Educational designs not possible with existing CFL systems (Kavnoudias <em>et al.</em>, 2000, p. 97; Kemm, Williams, Kavnoudias, Fritze <em>et al.</em>, 2001, p. 7.12).</td>
</tr>
<tr>
<td></td>
<td>• Problem-based learning (Kemm, Williams, Kavnoudias &amp; Fritze, 2001, p. 916).</td>
</tr>
<tr>
<td></td>
<td>• Activities supporting role-plays, e.g. student as ‘tutor’ (Fritze <em>et al.</em>, 2000, pp. 7.3-4), architectural designer/jury member (Willis, Hirst &amp; Yau, 2001, pp. 157-8), range of shoppers in virtual shopping mall (Wallace <em>et al.</em>, 2003).</td>
</tr>
<tr>
<td>Students’ perceptions of their situation</td>
<td>• Sense of individualised communication with teacher (Margetts <em>et al.</em>, 2002, p. 131, 132).</td>
</tr>
<tr>
<td>Perceived good teaching encourages adoption of a ‘deep’ approach to learning.</td>
<td>• ‘Persona’ of the teacher, evoked by academic style of self-designed pages, use of novelties such as ‘rubber stamps’, regular communication evident in messages (Fritze, Kavnoudias <em>et al.</em>, 2001b, p. 909, Margetts, 2002 #284, p. 131).</td>
</tr>
<tr>
<td></td>
<td>• Opportunities to see the work of other students and their own learning progress.</td>
</tr>
<tr>
<td></td>
<td>• Course overview progress map (Fritze, Kavnoudias <em>et al.</em>, 2001b, p. 908, Margetts, 2002 #284, p. 130).</td>
</tr>
<tr>
<td></td>
<td>• Self assessment-style activities (Fritze <em>et al.</em>, 2000, p. 7.3-4; Margetts <em>et al.</em>, 2002, p. 130).</td>
</tr>
<tr>
<td></td>
<td>• Expression of confidence level (Kavnoudias <em>et al.</em>, 2000, p. 98).</td>
</tr>
<tr>
<td></td>
<td>• Ease of use by student (Margetts <em>et al.</em>, 2002, p. 131).</td>
</tr>
</tbody>
</table>

Student electronic learning portfolios implemented in OCCA can provide opportunities for students to reflect on their learning, print summaries of their work, or even provide information to future employers. For teachers, they
provide a window on the entire work of students across a course. Collaborative Learning Environments have been created within workshop settings using OCCA as a framework supporting different forms of structured and unstructured discourse between students, teachers and tutors. Other implementations have supported authentic and complex learning environments, game play approaches, role-plays and problem-based learning.

A CFL learning environment should not be thought of simply as a resource, or set of tasks, but also as a means of influencing the way students perceive their situation and consequently, how they might approach their learning (Sections 5.4 and 5.5). Possible ways in which OCCA might influence students’ perceptions of their situation is indicated in Table 9.5. For example a teacher can evoke a ‘persona’ by adopting an individual communication style in global and individual online comments, idiosyncratic design of OCCA pages, or ‘novelty’ items, such as rubber stamps. Making the work of a whole class visible and activities that encourage self-assessment or reflection can influence how a student perceives their situation in relation to others, or to their own progress.

These listed educational features of OCCA are illustrated in more detail in the cited publications and in the implemented project case studies in Sections 10.2 and 10.3.

9.4.2 Supporting the context of teaching and development

The second focus of the Pragmatic Educational Requirements Guide of Section 5.5 emphasises the need for teachers to be learners, actively researching the experiences of their students in order to refine their understanding and practice of teaching. Various ways in which OCCA has been employed to support this process are listed in Table 9.6 (see p. 143). For example, teachers’ understanding of misconceptions of their students has been facilitated through optimised summaries of student work. Opportunities for students to provide feedback can be embedded within individual learning activities. Moreover, the teacher has the capacity to affect immediate changes in the activities in response to this intelligence.

Table 9.6 identifies other ways in which the teacher’s role can be facilitated by customising the teaching environment, for example, with optimised Web templates for teachers to provide feedback and assessment. Structured channels have been set up that enable teachers to communicate with individual students, groups or the whole class, as well as course coordinators and tutors. That is, quite different learning community models can be supported, given that no technical distinction is made between users (9.3.1). The capacity for OCCA to improve the efficiency of teaching is evident from reports of the ease of changing course content and reduced time for administration (Margetts et al., 2002, p. 132).
Table 9.6  Specific opportunities provided by OCCA to support the teaching and development context

<table>
<thead>
<tr>
<th>Key points</th>
<th>Implemented examples</th>
</tr>
</thead>
</table>
| **The teacher as learner**  
*Developing an understanding of student misconceptions, learning approaches, experience of learning. Reflecting on the teaching experience.* | • Optimised and progressive summaries of student work revealing misconceptions, variation between students etc. (Fritze et al., 2000, p. 7.4, Margetts, 2002 #284, p. 131).  
• Summarising dynamics of peer interactions (Kemm, Williams, Kavnoudias, Fritze et al., 2001, p. 7.7).  
• Student’s perceptions of confidence (Kavnoudias et al., 2000, p. 98).  
• Formative evaluative feedback from students (Margetts et al., 2002, p. 131).  
• Opportunities to adapt learning environment designs in response to new understanding (Fritze, Kavnoudias et al., 2001b, pp. 908-9; Kavnoudias et al., 2000, pp. 98-9, Margetts, 2002 #284, p. 130). |
| **The teaching environment**  
*Supporting the teacher with rich views of the student experience, opportunities to adapt the learning environment and contribute feedback.* | • Optimised templates for efficiently reviewing and annotating student work (Fritze, Kavnoudias et al., 2001b, p. 909; Kemm, Williams, Kavnoudias & Fritze, 2001, p. 917; Margetts et al., 2002, pp. 131-2).  
• Ability to scan all class responses to facilitate ranking (Kemm, Williams, Kavnoudias & Fritze, 2001, p. 917).  
• Facilitating link between workshop tutors and supervising academic staff (Kemm, Williams, Kavnoudias, Fritze et al., 2001, p. 7.7, Kemm, 2001 #154, p. 917).  
• Sending messages to students on educational and administrative issues (Margetts et al., 2002, p. 131).  
• Supporting new CFL models (Kavnoudias et al., 2000, p. 98).  
• Ease of changing course content (Kavnoudias et al., 2000, p. 96).  
• Reduced time for administration (Margetts et al., 2002, p. 132). |

9.4.3  Supporting student learning activities necessary for user-active learning

The third focus of the Pragmatic Educational Requirements Guide looks at activities necessary for academic learning: articulation, feedback, adaptation, apprehending structure, theory to practice and reflection (Table 5.5, p. 59). Opportunities provided by OCCA are listed in Table 9.7 (see p. 144).

Examples of articulation by students have ranged from simple text questions to highly specialised interactive tools, such as architectural design tools or interactive flow diagrams. OCCA has been used to frame group brainstorming and discussions within classroom Collaborative Learning Environments (Section 10.2). Feedback has been provided through annotations of student work, students voting on each others’ architectural designs and an ‘Editorial Board’ made up of teachers who reviewed students’ submitted papers. It is also possible for immediate feedback to be embedded within question pages. Many possibilities exist for students to adapt and re-draft their work in the light of feedback from teachers, other students, or their own reflection, made possible by the ability of OCCA to retrieve any previous work. Importantly in this process, a history of the re-drafts can easily be created.

The requirement for students to relate details of evidence within the broader structure of academic discourse relates to the overall structure and multiple activities of the course itself. This is inherent in designs such as the Virtual Shopping Mall (Wallace et al., 2003), in which students are engaged at many levels as they explore an immersive virtual environment, self-assessing skills, undertaking authentic tasks and interpreting perspectives in role-plays, while framing a broader interpretive argument. The individual learning already discussed provide a basis for teachers to devise such environments for their specific discipline areas.
### Table 9.7 Opportunities provided by OCCA to support student activities for user-active learning

<table>
<thead>
<tr>
<th>Learning activity</th>
<th>Implemented examples</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Articulation</strong></td>
<td>• Individual writing within online activity (Margetts et al., 2002, p. 130).</td>
</tr>
<tr>
<td><strong>Making tacit knowledge explicit.</strong></td>
<td>• Brainstorming issues within a group (Kemm, Williams, Kavnoudias &amp; Fritze, 2001, p. 917).</td>
</tr>
<tr>
<td></td>
<td>• Interpreting video media and images (Margetts et al., 2002, p. 130).</td>
</tr>
<tr>
<td></td>
<td>• Interacting with simulations or specialised interfaces (Willis et al., 2001).</td>
</tr>
<tr>
<td></td>
<td>• Identification and ranking of key concepts (Kemm, Williams, Kavnoudias &amp; Fritze, 2001, p. 917).</td>
</tr>
<tr>
<td></td>
<td>• Reviewing the work of others (Fritze et al., 2000, p. 7.3; Kemm, Williams, Kavnoudias, Fritze et al., 2001, p. 7.7, Kemm, 2001 #154, p. 917).</td>
</tr>
<tr>
<td></td>
<td>• Supporting discussion and debate within a computer-supported collaborative learning classroom (Kemm, Williams, Kavnoudias &amp; Fritze, 2001, p. 915; Margetts et al., 2002, p. 130).</td>
</tr>
<tr>
<td><strong>Feedback</strong></td>
<td>• Annotation of work by teachers (Fritze et al., 2000, p. 7.4; Margetts et al., 2002, p. 131).</td>
</tr>
<tr>
<td><strong>Guidance, reinforcement, praise in response to articulation.</strong></td>
<td>• Messages to all students (Margetts et al., 2002, p. 131).</td>
</tr>
<tr>
<td></td>
<td>• ‘Editorial Board’ review of written reports (Kavnoudias et al., 2000, p. 96).</td>
</tr>
<tr>
<td></td>
<td>• Reviews of work by peers (Fritze, Kavnoudias et al., 2001b, p. 909; Kemm, Williams, Kavnoudias &amp; Fritze, 2001, p. 917).</td>
</tr>
<tr>
<td></td>
<td>• ‘Rubber stamps’ (Fritze, Kavnoudias et al., 2001b, p. 909, Margetts, 2002 #284, p. 131).</td>
</tr>
<tr>
<td></td>
<td>• Immediate responses embedded within a question page (Fritze et al., 2000, p. 7.3-4).</td>
</tr>
<tr>
<td></td>
<td>• Students vote on other student work (Willis et al., 2001, pp. 158-9).</td>
</tr>
<tr>
<td><strong>Adaptation and re-articulation</strong></td>
<td>• Recall of previous work within a follow-up activity (Kemm, Williams, Kavnoudias &amp; Fritze, 2001, p. 917).</td>
</tr>
<tr>
<td><strong>Revising ideas in the light of new information, feedback or reflection.</strong></td>
<td>• Redrafting (Fritze et al., 2000, p. 7.4; Fritze, Kavnoudias et al., 2001b, p. 908).</td>
</tr>
<tr>
<td></td>
<td>• Respond to peer reviews of their own work (Kemm, Williams, Kavnoudias, Fritze et al., 2001, p. 7.7).</td>
</tr>
<tr>
<td></td>
<td>• Progressively reveal issues for consideration in later drafts (Kemm, Williams, Kavnoudias, Fritze et al., 2001, p. 7.7).</td>
</tr>
<tr>
<td></td>
<td>• Revise after reviewing work of other students (Wallace et al., 2003).</td>
</tr>
<tr>
<td></td>
<td>• Initial response, self-assessment and redraft (Fritze et al., 2000, p. 7.3-4).</td>
</tr>
<tr>
<td><strong>Apprehending discourse structure</strong></td>
<td>• Inherent in the design of complex problem-based and authentic activities (Kemm, Williams, Kavnoudias &amp; Fritze, 2001, p. 915; Wallace et al., 2003).</td>
</tr>
<tr>
<td><strong>Managing detail within the structure of a broader argument</strong></td>
<td>• Access to complementary modes of learning activity (e.g. identification of key concepts, report writing, structured discussion and communication with teacher) within course overview (Fritze, Kavnoudias et al., 2001b, p. 908).</td>
</tr>
<tr>
<td><strong>Theory to practice</strong></td>
<td>• Applying design concepts within a simulated design environment (Willis et al., 2001).</td>
</tr>
<tr>
<td><strong>Applying understanding to real-world problems, ‘authentic’ and ill-defined tasks.</strong></td>
<td>• Problem based learning, real-world problems (Kavnoudias et al., 2000, p. 93; Kemm, Williams, Kavnoudias, Fritze et al., 2001, p. 7.6).</td>
</tr>
<tr>
<td></td>
<td>• Authentic tasks within virtual environment (Wallace et al., 2003).</td>
</tr>
<tr>
<td></td>
<td>• Professional writing and communication skills (Kavnoudias et al., 2000, p. 93).</td>
</tr>
<tr>
<td></td>
<td>• Role-play (Fritze et al., 2000, pp. 7.3-4; Wallace et al., 2003; Willis et al., 2001, pp. 157-8).</td>
</tr>
<tr>
<td><strong>Reflection on learning</strong></td>
<td>• Learning portfolios (Kavnoudias et al., 2000, p. 98; Margetts et al., 2002, p. 131)</td>
</tr>
<tr>
<td><strong>Tying together content goals, activities and feedback. Consideration of the learning process.</strong></td>
<td>• Overviews of course progress (Margetts et al., 2002, p. 130).</td>
</tr>
<tr>
<td></td>
<td>• Histories of submissions, responses of whole class or group, weekly summaries of activities (Kemm, Williams, Kavnoudias &amp; Fritze, 2001, p. 917; Wallace et al., 2003).</td>
</tr>
<tr>
<td></td>
<td>• Reflect and review their own group work using guidelines provided (Kemm, Williams, Kavnoudias, Fritze et al., 2001, p. 7.7).</td>
</tr>
<tr>
<td></td>
<td>• Indicating level of confidence (Kemm, Williams, Kavnoudias &amp; Fritze, 2001, p. 917).</td>
</tr>
</tbody>
</table>

In a similar manner, students have been assisted in relating their conceptual understandings to experiential environments, for example, in simulated real world settings, authentic tasks, role-plays and professional activities. Last but not least, opportunities for students to reflect on their learning experience has been previously
indicated and is facilitated by the ability for teachers to structure students’ access to any previous work, self-assessment or communications in an optimised form.

### 9.5 Summary

This chapter has looked at the outcome of the first goal of the study, the production of a generic online learning system. Over four years in the course of the study, this product evolved through distinct phases characterised by particular technical and educational design approaches, although these need to be viewed in the context of ongoing professional activity. That is, previous phases of software development pre-dating the action research study underpinned the first iterations of the design, while development of the product has continued after the formal period of action research study.

A total of seven major development phases were identified:

- the ‘CAL’ and ‘TutorialTools’ phases (1991–4) – interactive tutorial application developed within a departmental setting;
- the ‘TutorialEngines’, ‘Learning Engines’, ‘Activity Manager’ and ‘OCCA (client-side)’ phases (1996–2000) – the generic online learning system developed within action research component of this study; and
- the ‘OCCA (server-side)’ phase (after late 2000) – continued development of the OCCA system within the Central Unit.

An examination of the contemporary project descriptions across all these development phases reveals a consistency in underlying aims to support rich learning and teaching opportunities and a modular technical structure. The manner in which these aims were actually implemented varied significantly, however, as the design made a profound shift from highly interactive learning activity ‘engine’ to a low-level architecture for managing learning transactions within a course. The ‘client-’ and ‘server-side’ versions of OCCA are equivalent in terms of educational functionality and are treated together unless a distinction is necessary.

The final OCCA system can be most simply described as a combination of Web server and database with additional functions for managing learning transactions. It contains no pre-defined learning structures and makes no technical distinction between teachers or students, who both save ‘work’ to the database or retrieve it. Fundamental technical features of OCCA are the standardised ‘State Description Protocol’ used to store any form of information; the use of ‘embed tags’ on Web pages to retrieve any information from the database; and the capacity to support highly interactive objects.

These fundamental capacities of OCCA can be crafted into innovative learning and teaching structures that challenge traditional assumptions about roles and activities of students and teachers. Examples from existing OCCA-based curriculum projects were mapped against a framework of requirements to support learning and teaching contexts and student activities necessary for academic learning.

In the following chapter, the capacity of OCCA to support, and indeed transform, learning and teaching is investigated in more detail in two particular curriculum case studies, followed by a broader review of OCCA-based curriculum implementations across the University.
10.1 Introduction

The final outcome of the software production goal, the Online Courseware Component Architecture, was described in the previous chapter in terms of its functional design and capacity to support the development of academic learning environments. In this chapter, these capacities are examined in the context of actual curriculum projects:

- a Collaborative Learning Environment (CLE) in Physiology (Section 10.2);
- a flexible learning environment in the Department of Educational Development, Faculty of Education (Section 10.3); and
- additional curriculum applications across the University (Section 10.4).

The first two sections describe case studies of how OCCA has been used by individual teachers in curriculum projects to transform their teaching approaches. These provide a detailed background of the educational setting.
so that the significance of OCCA can be understood in the wider educational context. The Physiology project, in
particular, provided an important collaborative research opportunity for this study and was instrumental in
shaping the nature of the software product. This is indicated in the adoption of different versions of the software
development over an extended period. Teaching staff in Education later adapted the CLE model within another
discipline setting. In both projects I had significant involvement in the CFL design and the development of the
OCCA Web sites, although course content, oversight of the broader teaching model and evaluation were the
direct responsibility of the teachers concerned.

The third section of the chapter examines the broader uptake of OCCA in some 25 curriculum projects across a
wide range of disciplines across the University. Many of these projects were independently produced by other
staff in the Central Unit.

10.2 A computer-facilitated Collaborative Learning Environment in
Physiology

The on-campus, computer-facilitated Collaborative Learning Environment (CLE) developed in the Department
of Physiology, exemplifies the capacities of OCCA to support innovation within the curriculum. This section
draws primarily from published accounts of this teaching initiative (Kavoudias et al., 2000; Kemm,
Kavoudias, Fritze et al., 2000; Kemm, Kavoudias, Weaver et al., 2000; Kemm, Williams, Kavoudias &
Fritze, 2001; Kemm, Williams, Kavoudias, Fritze et al., 2001). The project was funded under the T&L(M&ET)
funding program for innovation in teaching.

The decision to adopt a new teaching approach in the Department was a response to the need for developing
critical thinking and communication skills of undergraduate students. Research supervisors reported that
graduate science students were good at reading, understanding and collating information, but were notably weak
in identifying, documenting and articulating key issues (Kemm, Williams, Kavoudias & Fritze, 2001, p. 914).
Later year Science students, in particular, demonstrated difficulty identifying and discussing key physiological
concepts in literature surveys and project reports. The wide variation in the course timetables of Science students
also made it difficult to establish effective study groups and they missed opportunities available to students in
Medicine and Dentistry, where the vocational focus and overlapping timetables provided opportunities for a
stronger culture of collaboration (Kavoudias et al., 2000, p. 915).

10.2.1 A computer-facilitated collaborative learning environment

Scheduled Computer-Aided Learning (CAL) sessions running within a CLE were first introduced in 1997,
coinciding with a reduction in lectures from four to three per week (Kemm, Kavoudias, Fritze et al., 2000, p.
8.2-3). These were designed to help students to be more perceptive in their scientific reading and more analytical
and critical in their judgements about content and conclusions. The CLE sessions were also designed to bring
different experiences to student learning, in order to address a wide variation in student achievement levels,
approaches to learning and cultural backgrounds, by using a diverse range of computer-assisted teaching
formats. Small groups were used to expose students to different views and interpretations from which they could
resolve their differences and develop a ‘consensus’ point of view. Importantly, the sessions were designed to
integrate with other learning resources such as lectures and printed texts, with students encouraged to engage in
continuous reflection and evaluation (Kemm, Kavnoudias, Weaver et al., 2000, p. 10).

Key features of the CLE that evolved were (Kavnoudias et al., 2000, p. 96):

- a dedicated physical space that encouraged student interaction in a friendly and informal environment that would promote peer learning and teaching and facilitate access to resources;
- the presence of a tutor (or ‘facilitutor’) to guide and assist learning;
- weekly interactive tasks, including a variety of Web-delivered components, independent computer tutorial programs and paper-based activities, designed to reinforce and/or supplement lectures and focus on key concepts that students had difficulty with; and
- a semester-long ‘Group project’, in which students worked in groups to write a report on a topical physiological problem to be submitted to an ‘Editorial Board’ for review.

A range of different computer-based techniques, including activities developed in OCCA and its preceding versions, were therefore well integrated within the broader educational model.

### 10.2.2 Weekly Computer Assisted Learning components

Within each CLE workshop, students undertook a variety of group tasks in a range of computer- and text-based formats. These activities took approximately 1.5 hours each session, during which time the computer operated as a virtual tutor to help them check their answers, provide a level of feedback and to pose further questions in order to stimulate interpretations and group discussion. Highly interactive tutorial programs developed in the Department and externally produced modules, proved effective for developing an understanding of difficult concepts (Kemm, Kavnoudias, Weaver et al., 2000, p. 12, 17). Tutorials were developed by teaching staff using the TutorialTools software for students to test their knowledge with a variety of multiple-choice and open-ended questions at the end of each session.

A key aspect of the CLE workshops was the ability to produce sufficient materials for 24 weeks that could be easily refined after evaluative feedback. The teachers used the ‘Learning Engines’ version of the generic software (Fritze et al., 1998) to produce a number of interactive Web exercises, for example, tasks involving sequences of events in a physiological process (Kemm, Kavnoudias, Weaver et al., 2000, p. 16). Students found these exercises challenging and rewarding, causing much discussion as they explored many of the possible solutions. Figure 10.2 illustrates a typical activity configured by the teachers in which students drag ‘physiological events’ from the top container into correct order within the lower one. The feedback button displays an explanation of the current sequence in the ‘Comments’ window that is responsive to events out of sequence and also offers hints at different stages of the exercise.
Figure 10.2 Learning Engines implementation of a physiological events ‘sorting’ question

Other Learning Engines activities enabled students to represent relationships in graphical form (Figure 10.3). Teachers could include explicit feedback criteria responding to properties of the drawn curve, such as the start and end coordinates, gradients and curve type, such as ‘exponential’, or ‘straight line’ (Kennedy, 2001, pp. 245-291; Kennedy & Fritze, 1998; Kennedy et al., 1997a; Kennedy et al., 1997b).

Figure 10.3 Free-form graph sketching tool (after Kemm, Kavnoudias, Weaver et al., 2000, p. 16)

The teachers reported that students found the textual feedback in these forms of exercises helpful to their learning (Kemm, Kavnoudias, Weaver et al., 2000, p. 16). While they found the content quite challenging, the computer-aided tutorials, in general, gave them a better idea than lectures of the level of understanding required for physiological processes. Students also developed appropriate learning strategies, such as the ability to...
explore concepts using interactive programs, and to reinforce lectures by reflecting on the material and redoing components of the CAL.

10.2.3 The semester-long Group Project

The second component of the CLE workshops, of vital importance to this study, was the on-campus semester-long ‘Group Project’. The development of this particular learning activity during 2000 played a pivotal role in the evolution of the generic learning system in this study. In this section, the background to the project and educational structure of the activity are described, while in Section 13.3 the development process is treated as a case study of collaborative research.

The Group Project was designed to help students be more perceptive in their reading of short excerpts of scientific writing and to communicate their knowledge more effectively (Kemm, Kavnoudias, Weaver et al., 2000, p. 12). The collaborative aspect of the exercise encouraged them to work cohesively and improve their collective skills in negotiation, communication, reading and writing, and in reviewing their science.

It was first trialled as a paper-based activity in 1998, with students working on a topic covered in published papers. Over the semester, they worked as individuals and in groups to define the problem, reflect and revise their work, review peer groups’ work and deliver a final oral presentation. Despite receiving considerable assistance within the scheduled times, the assignments revealed that students still had difficulty in identifying key concepts and communicating ideas within their working group (Kemm, Williams, Kavnoudias & Fritze, 2001, p. 914). The trial demonstrated the need to develop a computer-assisted approach to support this initiative.

In 1999, the ‘TopClass’ learning management system was used to facilitate group discussions and work submissions over the semester (Kemm, Kavnoudias, Weaver et al., 2000, p. 12). They were provided with weekly feedback and after six weeks submitted their report to another group for peer review. Students were enthusiastic about the topical task and engaged in lively discussion, although they were often frustrated by the features of the system, which proved to be inflexible and inconvenient to use for both students and the teacher.

In Semester 1, 2000, the OCCA learning system was introduced as a more effective means for students to develop their submissions and for teachers to provide feedback using efficient templates for reviewing and annotating students’ work. As a result of the previous student feedback and observations of group dynamics, the group size was reduced to three, with classes of 40 students repeated several times each week in the collaborative learning laboratory with 15 computers. The group project was undertaken in the last 30 minutes of the scheduled weekly CLE session. Assessment of the project was based on participation, collaboration and effective use of the processes and less on the quality of the final submission (Kemm, Williams, Kavnoudias & Fritze, 2001, p. 916).

The structure of the project is summarised by the Students’ ‘Introduction and Schedule’ page from Semester 2, 2000, shown in Figure 10.4. The main menu on the left provides access to each week’s activities, which were made active progressively during the semester. The weekly sessions are organised as different learning tasks: thinking about key concepts; report writing; discussion and reflection; and, in later weeks, interaction with the peer group. Groups may send a message to the tutor, or read a reply from the tutor, indicated by icons in the ‘Tutor interactions’ column.
At the commencement (week 2), student groups were organised and allocated one of four real-world problems that would be addressed over the semester. The allocation of topics was handled electronically so that the appropriate topic was displayed in the students’ pages. During this week, students individually researched the problem and emailed their findings to the ‘facilitutor’.

In the next week (week 3) the groups were provided with three tasks, to ‘brainstorm’ the issues as a group, record and prioritise ‘key phrases’ and write a ‘first draft’ of their report. Figure 10.5 illustrates the second task page on which they can read their previous brainstorming submission and enter key phrases. The phrases can be dragged into order on the page and their relevance indicated. On each page they can save their work as often as they like, but once they press the ‘submit to portfolio’ button, it can no longer be modified, but the link on the left to the next task becomes active. The portfolio of submitted work can be accessed at any time.

Figure 10.4 Physiology ‘Group Project’ overview page summarising weekly tasks, progress and feedback

<table>
<thead>
<tr>
<th>Week</th>
<th>Key concepts</th>
<th>Writing</th>
<th>Discussion &amp; reflection</th>
<th>Peer interactions</th>
<th>Tutor interactions</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Individual research</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Brainstorm ✓</td>
<td>Drill 1 ✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ideated keywords ✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Review ✓</td>
<td>Drill 2 ✓</td>
<td>Guided discussion ✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Drill 3 ✓</td>
<td>Reflection ✓</td>
<td>Send drill 3 to peers ✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Review peer pages</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Local submission</td>
<td>Evaluation</td>
<td>Reply to peer review</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Key ✓ = submitted, ✓ = comments in error, ✓ = peer feedback
In subsequent weeks the groups were able to submit work to their ‘portfolio’, send ‘comments’ to the tutors, read feedback, ‘post’ a draft to their allocated peer group for review, ‘reply’ to the peer group and submit the final draft to the ‘Editorial Board’. The labels for these activities were designed by the teachers to align with the educational model of the activity. From a technical perspective, these labels are arbitrary and describe a particular arrangement for saving records or accessing them from other pages. These educational concepts, and others such as the ‘portfolio’, ‘rubber stamps’ and ‘confidence indicators’, all evolved during the design and implementation of this curriculum project (Fritze, Kavnoudias et al., 2001b, pp. 908-9; Kavnoudias et al., 2000, p. 98). This aspect of the collaborative development is described with a narrative history (Chapter 11) and collaboration case study in Section 13.3.

From the teaching perspective, various Web page templates were designed to give academic assessors appropriate views that (Kemm, Williams, Kavnoudias & Fritze, 2001, p. 917):

- summarised each group’s activities in a particular week;
- showed a group’s final submission, peer review, and their responses to the review; and
- compared different groups’ approaches to specific tasks.

For example, Figure 10.6 shows one particular Web template found to be very effective by teachers acting as the ‘Editorial Board’, for reviewing and responding to group work in the final week (Fritze, Kavnoudias et al., 2001b, p. 910). Here a tutor can click on the left-hand list to display the work of a particular group, including
their final submission and elements of the ‘conversation’ with the student peer group. Predefined popup menus and text areas enable them to efficiently enter feedback. Other templates and summaries can be selected in the administration area at the top left.

![Web template used by ‘Editorial Board’ to assess the group essay and peer review process (after Fritze, Kavnoudias et al., 2001b, p. 909)](image)

**Figure 10.6** Web template used by ‘Editorial Board’ to assess the group essay and peer review process (after Fritze, Kavnoudias et al., 2001b, p. 909)

### 10.2.4 Evaluation of the Physiology Collaborative Learning Environment

Teaching staff carried out extensive evaluation of the broader computer-assisted CLE approach in Physiology in 1998, 1999 and 2000 (Kemm, Kavnoudias, Weaver et al., 2000, p. 13; Kemm, Williams, Kavnoudias & Fritze, 2001, pp. 917-8). A number of evaluation strategies and data collection approaches were employed, including surveys; exam results; facilitators’ observations of students’ work and participation; records of student work;
meetings between the course developers and tutors; and focus group interviews with students. Development of an understanding of student reactions to the program was facilitated through the key role of the ‘facilitutors’ and the close location of the academic developers to the CLE laboratory, which encouraged informal interactions with students and tutors.

A particular effort was made to determine the effect of the CLE on examination outcomes. Analysis of the data showed that collaborative learning assisted students to achieve significantly higher examination outcomes in the written component, although it did not change the Multiple Choice Question component. The results were markedly higher for all groups except the low achievers, although the improvement could not be ascribed to any particular attribute of the CLE. Those who markedly improved their result over first year obtained a better collaborative learning score, primarily in the written response component of the examination (Kemm, Williams, Kavnoudias & Fritze, 2001, p. 918). The data indicated that of the students who undertook the group project and did well, many obtained improved examination outcomes, especially to written answer questions. While a good group project result did not guarantee an improvement, certainly a very large majority of students whose marks worsened from first year, did poorly in the written answers and also performed poorly in the group project.

Student surveys in Semester 2, 2000 indicated that the students rated the ease of use and feedback on the OCCA-based pages highly (Kemm, Williams, Kavnoudias & Fritze, 2001, p. 918). They rated group work as useful, enjoyable and an important part of their development. While they did not think the group project increased their knowledge much, this single exercise was not intended for that purpose. It was noted that many students thought they should be left alone as they felt they already had the required scientific reading and reporting skills; however, a formative assessment assignment and exam answers showed they were misled about their own abilities.

It was difficult to directly attribute improvement to particular attributes of the CLE, for example, the OCCA-based group project, as learning occurs within a much wider context of the student experience and multiple activities within the course. While the teaching approach was clearly evolving with teachers’ understanding and the design of computer-based approaches, it was concluded that:

The use of a customisable learning environment based on OCCA has given us significant advantages in producing some of our desired learning outcomes compared with our previous efforts to use a high level learning framework that had restricted our flexibility. Generating structured collaborative exercises adds value to any high level framework, such as WebCT, while allowing academics to produce effective student-centred learning environments without specialist programmers.

(Kemm, Williams, Kavnoudias & Fritze, 2001, p. 919)

The action research collaboration with teachers in Physiology will be examined more fully in Section 13.3.
10.3 A student-centred online flexible learning environment in Education

The second case study involving an OCCA-based curriculum innovation was undertaken by teaching staff from the Department of Educational Development within the Faculty of Education. This implementation occurred outside the main period of action research prototyping in this study, in a project titled the ‘Flexible Learning and Interaction Project’ (FLIP), funded through a Faculty IT grant during 2001. The report in this section draws heavily on a published account of the project (Margetts et al., 2002). In the project I was an ‘associate investigator’, providing educational and technical advice and facilitating teachers to become self-sufficient in setting up and running an OCCA teaching site. The teachers were responsible for all curriculum aspects and student evaluation, with other assistance from the Faculty of Education Information Technology Unit and the central Teaching, Learning and Research Support Department, who maintained the OCCA server and undertook video production. The basic educational philosophy draws from the Physiology CLE model, using many of the educational constructions, although the materials were developed in the most recent server-side version of OCCA. This is the first of a number of OCCA-based courses implemented in the Department.

The project was designed to address difficulties identified in the subject ‘Physical Development’ in the Bachelor of Early Childhood Studies (Margetts et al., 2002, p. 129). This subject required students to become familiar with children’s physical development and to develop observational skills, which are embedded in theory, for practical application. It was previously undertaken using a traditional paper-based lecture/tutorial approach emphasising on-site attendance. As part of this, students undertook a child study using a traditional in-home observation, paper-and-pencil model, which raised problems with authentication and assessment, as well as some ethical issues. Students had limited opportunities for guided interactions and flexible learning, or opportunities for collaboration within the large tutorial groups. It was also observed they had difficulty accessing, or chose not to access, important library-based audio-visual resources.

The aims of the project were therefore to:

- create a student-centred online flexible learning environment that supports and enhances lectures and tutorials and can be adapted to individual subject requirements within the Faculty of Education and other faculties;
- enhance student understanding of key concepts related to physical development;
- develop observational skills related to practical application;
- foster personal learning skills by engaging students in critical thinking, reflection and discussion; and
- foster linkages between students and teachers (Margetts et al., 2002, p. 130).

The approach adopted was for the teacher to develop a range of online structured tasks using a standard Web page editor (Dreamweaver), to supplement and enhance existing learning and teaching approaches. This was achieved through open-ended and reflective questioning techniques; summary pages of students’ work and learning experiences; various levels of feedback between students and lecturer/tutors; and extensive photographic, video and other online multimedia resources. A key feature of the project was the ability for
Departmental academic staff to update materials and activities as required and to incorporate new activities or change the emphasis of tasks in response to student feedback or lecture content.

10.3.1 Structure of the online activities

The main topics and their content were identified by the academic team members (Margetts and Ure). Learning was structured on three, three-week learning cycles, within which students completed and submitted both individual and group learning activities accessed through the respective ‘Overview Page’ (Margetts et al., 2002, p. 130). For example, the ‘Individual Overview’ Web page (Figure 10.7) provides students with links to weekly activities (left-hand column) and an indication of work completed (second column). The tick icons indicate which weekly tasks had been saved as a work-in-progress, while the lock icon indicates that the week’s work was ‘submitted’ and could not be re-edited. Comments to the tutor and feedback are indicated in the right-hand columns with text and icons.

![Figure 10.7 Individual Overview page of weekly tasks, summaries, progress and feedback](after Margetts et al., 2002, p. 130)

In weeks 1, 2, 4, 5, 7 and 8, students worked as individuals to submit the tasks online by the required date (Figure 10.7). In weeks 3 and 6, they worked in groups of three in scheduled tutorial times in computer laboratories, to revisit work undertaken during the previous two weeks and submit revised responses for assessment (Margetts et al., 2002, p. 130). The group members discussed issues arising from their individual work and made arrangements for the completion and submission of activities. As with the individual tasks, group work could be also be completed at times and places of the students’ choosing, to be submitted online by the set time. In the final cycle in week 9, the group activity involved a range of tasks designed to revise and assess students’ understanding of concepts related to Physical Development.
For each week, a ‘Task List’ page (Figure 10.8) provided an overview of the activity, a ‘weekly message’ from the teacher and links to the main tasks. In this example, tick icons indicate that the first two tasks have been saved. When the individual tasks have been completed to the student’s satisfaction, they can all be ‘submitted’, together with a comment to the teacher and indication of confidence, by clicking the ‘Submit all tasks to your portfolio’ button.

![Figure 10.8 ‘Task List’ page for week one showing message from teacher and completed tasks](image)

10.3.2 Learning and administrative elements

While certain educational ideas used in this course derived directly from the Physiology CLE learning model (Section 10.2), for example, the subject overview page, use of icons, rubber stamps and student portfolio, additional educational constructs were developed. The module demonstrated its own particular educational ‘flavour’, based in part on its integration within the course, the style of Web pages developed by the teachers and design elements for both learning and administration that were crafted within the OCCA system. The following learning elements characterised the functionality of the site from the students’ viewpoint (Margetts et al., 2002, pp. 130-1).

**Video clips:** many short QuickTime clips were used as a basis for students to make links between theory and aspects of child development. The benefits of video to support student learning include the ability for replay and slow motion, not available in real-life.
Self assessment and reflection: pop-ups and roll-overs were used in some tasks to encourage students to self-assess initial responses against a set of criteria.

Reflection on previous work and collaboration: the group activities provided opportunities for students to revisit previous work and to share and refine their understanding of key concepts with peers.

Summary page: students were able to access a summary of their task responses for each week from the Group and Individual Overview pages.

Learning Portfolio: students could access progressive records of work completed, ongoing evaluation and feedback from tutors in the portfolio. This was easily accessible and students could print hardcopies for tutorials, review and study purposes.

Save function: this enabled students to save at any stage, with the time of last saving indicated. Tick icons on the weekly task and overview pages indicated the task was ‘in-progress’.

Submit function: a ‘Submit all tasks to your portfolio’ button on the weekly task page was used at the conclusion to the week’s work, after which no further editing was possible. This was indicated by a lock icon on the overview, with the save and submit buttons on each page replaced with a status message.

Additional OCCA-supported elements that facilitated teaching administration included:

Tutor/lecturer overviews of student work and feedback to students: template pages enabled the lecturer/tutor to review and respond to student work. For example, the template in Figure 10.9 provided an overview of task status and student comments for each group, with a facility to send comments and ‘rubber stamp’ to individual group members. This page is showing the ‘work’ of the ‘Tutors’ group. Other pages provided optimised summaries of student work.

![Figure 10.9 Tutor ‘template’ overviewing group progress and comments, with feedback facility (Margetts et al., 2002, p. 131)](image-url)
Weekly message: a message appearing on the weekly overview page for all students. This could be easily updated from a Web page template by the teacher, to alert students to important pedagogic, administrative or technical issues as they arose.

10.3.3 Assessment of student work

Assessment was based on various aspects of the project activities, including completion of individual learning tasks, group work and an examination (Margetts et al., 2002, p. 131). The problem of authentication of work completed outside supervised tutorial periods is noted, although this is similar to that for traditional written work. The allocation of marks for different activities and for attendance was designed to encourage participation and authentic work. Assessment tasks were modified to reflect the change in focus of the course. Additionally, it was expected that knowledge and understandings, skills and attitudes gained in this subject would be reflected in students’ linked teaching practicum. Student work was assessed on a range of criteria that included completion of tasks, understanding of concepts, skill development and evidence of reflection and analyses.

10.3.4 Project Evaluation

Ongoing formative evaluation was fundamental to the development of the project and used to refine materials and inform the development of new materials for later weeks, as well as to provide feedback to students. It was integrated into the online materials, providing opportunities for students to express their feelings about the content and value of weekly activities and to offer any other comments or suggestions to the teacher (Margetts et al., 2002, pp. 131-2). Additional data was gathered at the end of the project from an online questionnaire and a group discussion with students.

The focus of the evaluation was on qualitative data to develop an understanding of how students perceive this new form of learning and to provide guidance on how to refine the approach in following years and other projects (Margetts et al., 2002, pp. 131-2). Students particularly appreciated the videos and other visual representations of childhood development, which made it easy to make links with lectures and readings. They found the regularity and detailed nature of the assessed tasks related well to tutorials and was less stressful than having just one or two assignments. (Weekly tasks were typically composed of around 20 individual questions that required them to interpret an image or video). Group work was found to be good for sharing ideas and learning, although there were some problems when not all the members contributed fully. Some students did not like the idea of the group work revisiting work undertaken as individuals and wondered why this was necessary. (The group pages often repeated questions undertaken by individuals so that students would expand their understanding within group discussion.)

Students appreciated being able to access FLIP from home, although some were frustrated at the difficulty of downloading video clips, due to the high quality format used to preserve information content within the context of campus-based delivery. There are future plans to incorporate such resources onto a CD-ROM to be used in conjunction with the online site.

Student responses in the group discussion on what they liked the most included (Margetts et al., 2002, p. 132):

“I liked the visual aspect”.

The “variety was good, but not for every subject”.
“It was good to get comments and a picture from Kay”.
“It was easy to use and I liked doing work in groups”.
“I liked the ‘fill-in-the-gaps’ exercises”.
Students also commented that they liked doing work on a regular basis, as it was “better than assignments”.

In addition to the video delivery problems, students commented that they did not like the technical problems, for example, computers freezing or when they lost work. These problems decreased in time and they realised that some were a result of their own computers or Internet providers. One student commented that she would have liked to know if her answers were correct.

10.3.5 The teaching and development process

From my observations as an outside observer, it was clear to see that the teachers played a critical role in integrating the online component into the subject. This involved bringing the students ‘on-side’, so that they felt ‘part of the team’, helping to iron out any technical difficulties and providing feedback that would be used to improve this and later courses. The teachers were active in listening and responding to students’ comments. They maintained regular feedback, both online and in the classroom, and made timely refinements to the materials.

There was an increased workload for the teachers during the first year of implementation as they developed content, learnt about OCCA and constructed the Web pages (Margetts et al., 2002, p. 132). The development was largely undertaken on a week-by-week basis, with lessons learned incorporated into the design of later weeks. When run again in 2002, however, the workload was greatly reduced, as only minor refinements to pages were necessary. The optimised views of student work and online assessment tasks resulted in reduced marking time, compared to that for case studies undertaken by students in previous years.

From an academic perspective, the project challenged notions of what constituted effective activities. The introduction of a computer-supported approach was not seen just a matter of setting up particular technological functions and features, but required consideration of educational principles within the given learning and discipline context (Margetts et al., 2002, p. 132). In response to technical difficulties encountered by students and indications of increasing student competence in addressing and understanding these difficulties, it would appear that the incorporation of technology into learning activities actually assists students to better understand and apply that technology.

Since 2001, the Department of Learning and Educational Development has extended its use of OCCA into other courses (see below). Projects of particular interest include ‘C-TALP’, which builds from the FLIP model in collaboration with Monash University; ‘ILK’, which is a funded ‘generic’ project in collaboration with the Department of Physiology and the University of Nottingham; and ‘REaLT’, which is a recently funded collaboration with Monash to package Modular Learning Activities (Appendix 7, p. 287).

10.4 Implementation of OCCA within the University

The previous sections have examined in detail the context and educational design of two specific OCCA-based case studies. This section examines the broader application of some 25 projects undertaken within 10 of the 11
faculty areas in the University. Appendix 7 (p. 287) summarised these in terms of their development approach and extensions made to the basic OCCA system, for example, using interactive Shockwave objects. A number of other sites have been set up for professional development resources and workshops (Fritze, Kavnoudias, Kemm & Williams, 2001a).

It is worth noting that:

- all projects were funded through the internal T&L(M&ET) competitive grant programs, between 1998 and 2002 (Section 1.3);
- three projects were collaborations with other institutions;
- the ‘Virtual Shopping Mall’ received a ‘highly commended (Web)’ award for exemplary use of electronic technologies in teaching and learning in tertiary education (ASCILITE, 2001). It also received the Telecommunication Users Association of New Zealand Interactive Award of Best Education Online (2001); and
- invited papers were presented at the Ed-Media 2000 Conference and at the Global Summit of Online Knowledge Networks in Adelaide in 2002 (Kemm, Kavnoudias, Weaver et al., 2000; Margetts et al., 2002).

The project information used in the following discussion of development approaches, extensions and educational elements, is based on feedback from TeLaRS staff and internal documentation, unless otherwise stated.

### 10.4.1 Production approaches

In general, the OCCA-based curriculum projects listed in Appendix 7 (p. 287) were funded by either the University or Faculties and were ultimately the responsibility of teaching staff. The Central Unit (in most cases TeLaRS, or prior to this, MEU) was responsible for the maintenance and ongoing development of the OCCA system. Bearing this in mind, and also that some projects have progressed through several iterations, four general approaches to production are apparent. These relate to the primary developers of materials and associated software, who may be:

- teachers within a departmental setting (‘Departmental’);
- project teams from the Central Unit working on behalf of teachers (‘Central Unit’);
- external developers working directly with departmental teachers (‘External’); or
- a combination of departmental teachers and the Central Unit.

Further, my involvement across these projects varied from:

- none at all;
- initial consultation with teachers and developers;
- conceptual design and prototyping; to
- full collaboration in educational design and development over the life of the project.

### ‘Teacher’ as developer

Seven OCCA-based funded projects have the primary aim of making teachers self-sufficient in the on-going development of their own learning materials. This approach is the focus of this study and has involved me in
collaborative projects with academic staff in the departments of Physiology and Learning and Educational Development as illustrated in the case studies of Sections 10.2, 10.3 and 13.3.

‘Central Unit’ as developer
A distinctly different approach to development, adopted in some 17 projects, has been for the Central Unit to undertake all OCCA site production, working to specified requirements established with academic project leaders. In these projects, OCCA can be seen as a *specialised development environment* used by educational designers and programmers for crafting solutions to the curriculum requirements of teachers. These often focused on the production of interactive Shockwave objects to extend the capacities of OCCA (Section 9.3.2). Such projects have also led to the development of additional high-level centralised tools running in parallel with OCCA. For example, the Researching History project in History began as an OCCA departmentally focused implementation (Fritze *et al.*, 2000), but was re-developed by the Central Unit around more specialised tools to support the administration of large groups across multiple history subjects.

‘External developer’ and department
A small number of projects were developed by departments employing external programmers to develop Web activities and additional specialised discipline interfaces. In these cases, the Central Unit provided initial consultancy for the project, specialist advice to the programmers, as well as ongoing access to the central OCCA server.

Combination of developers
Of particular interest is the 2002 ‘ILK’ project, to develop a set of packaged page elements, templates and support materials capable of increasing the accessibility of OCCA to a wider range of teachers. Within this project, TeLaRS is developing specific extensions to the OCCA system and staff development resources to facilitate ongoing site production by teachers and local support staff. In a current Education project, teachers commissioned the Central Unit to produce a specific interactive Shockwave object, which they incorporated into the activity pages themselves.

These different ways in which the OCCA system is currently being used demonstrate the multi-dimensional aspects of its diffusion into the institution.

10.4.2 Additional learning elements used to enhance OCCA
In addition to various production approaches, the projects in Appendix 7 (p. 287) vary in their use of extensions made to the basic OCCA functionality. These can involve different levels of programming, or the use of additional media resources and software applications as indicated below.

**System level extensions**
A number of centrally funded projects have resulted in the development of additional system applications by Central Unit staff, to provide specific educational functionalities to complement the more open-ended nature of OCCA. For example:

- ‘Quokka’ was designed to provide a simple, unified, question authoring and delivery system;
• ‘Briefcase’ is a specialist environment for sharing documents between students and tutors within role-plays, case-based exercises and simulations of professional practice; and
• ‘Forion’ is an online discussion forum allowing dynamic threaded discussions to be integrated into a Web site.

These applications operate on the same server system as OCCA within a common framework being developed by Central Unit staff called ‘Neo’. These applications are essentially independent, but share a common system, user administration and authentication components.

Page level extensions
While small JavaScript page functions are used in most projects for formatting and simple actions (Appendix A4.5, p. 281), some projects have seen the development of more sophisticated interactive tools running in the Web page. For example, the previously described page in Physiology enables students to enter and ‘sort’ key concepts into order (Figure 10.5). A mathematical interface produced for Engineering in JavaScript provides a sophisticated equation editor that takes students through extended problem solving exercises.

Interactive interface objects
The production of sophisticated interactive objects extending the basic OCCA functionality was a common factor in many of the projects produced by the Central Unit. In these cases, OCCA provides a convenient mechanism for saving and restoring complex data from such tools (Appendix A4.6, p. 282). For example, a design tool object in Architecture enabled students to create architectural plans, as well as to view and critically review the work of other students (Willis et al., 2001). Other discipline interfaces that have also been developed by Central Unit staff include optical instruments in Optometry, network design tools in Engineering, farm management maps in Agriculture, process diagrams in Chemical Engineering, interactive audio-based exercises in Music and plottable graphs in Education.

External functions
Finally, some OCCA projects in Appendix 7 (p. 287) have made use of additional educational resources, such as image databases, video or other media, Shockwave animations and spreadsheets to extend the learning environment and range of experiences.

10.4.3 Educational approaches
While it is not practical to identify the specific educational features identified in Section 9.4 within all projects, an indication of general approaches can be given. From the information available, the common educational elements that can be identified in the projects include student reflection; authentic contexts; reviews of the student experience; practice and self-assessment; and support for teaching administration.

Student reflection
A key feature of OCCA is its ability to provide students with access to their previous work or the work of others, in order to facilitate reflection on the learning experience. The use of learning portfolios, re-drafting, group discussion and review is a common feature of all the Department-developed sites as discussed in Sections 10.2 and 10.3. In both projects specific reflective exercises were set at the conclusion of the course.
**Authentic contexts**

The Virtual Shopping Mall aims to locate students within a genuine, complex real-world experience (Wallace *et al.*, 2003). Interestingly, to provide an immersing and motivating involvement in learning, the design juxtaposes the ‘real’ world of the shopping mall experienced through animation, QTVR acoustic cues, representation of actual shops and products, with the ‘real’ world of the computer game environment, exemplified by use of levels of competency and rewards. Other projects employ problem- or case-based environments, for example, in Animal Nutrition, Waste and Land Management and Neuropsychology. The latter project enables students to propose likely diagnoses based on progressively revealed information and to request patient tests and examine results. Some projects employ specialised tools that simulate ‘authentic’ activities such as the design tool in Architecture, Virtual Vertometer in Optometry, simulated trust accounts in TALT, mathematical tools in Discrete Maths or network engineering tools in BestNet. The Architectural History module also engages students in a role-plays in which they are first ‘designers’ and then ‘judges’.

**Review of student experience**

Most projects appear to have the capacity for teachers to review the work of students, and in many cases to provide feedback to students. This includes the capacity to review designs created in interactive objects such as Architectural and Network Engineering design tools, or the work of students in ‘workbooks’, ‘case notes’ or ‘portfolios’.

**Self-assessment and practice**

Some projects appear to focus on the self-assessment and practice exercises for students that operate independently from the teacher, for example, in Aural Studies. Drill and practice that can be carried out in a flexible and private manner can be important in certain contexts, and here the form of the interactions can be optimised for the discipline requirements.

**Teaching administration**

The Essay Proposal Submission system in History was designed specifically to facilitate the efficient online feedback and annotation of student essay proposals. Other projects refer to the ability of teachers to configure or author exercises for students and, in particular, to the efficiency of reviewing and marking student work online.

10.4.4 Roles within OCCA-based developments

This final focus on OCCA-based curriculum projects in Appendix 7 (p. 287) looks at a possible breakdown of the roles of individuals in faculties and the Central Unit (see Table 10.1). The overlap between roles reflects the varied nature of projects and the skills and resources available within different academic departments (including project funding). Suggested primary responsibilities are indicated in bold.

While much of the focus of development has been on individuals, such as teachers and developers, the institution operates according to an organisational structure. For example, within the TeLaRS Department of the Information Division (the current ‘Central Unit’) there are more specialised sections. Courseware Development Services (CDS) focuses on educational design, media production and programming of individual curriculum projects; Research and Evaluation Services (R&ES) undertakes evaluation and research investigations, while
Learning Resources (LR) works more directly with teachers in professional development and information literacy (Table 10.1). In addition, departments and faculties will have their respective local IT and educational support units, which are not considered separately here.

Table 10.1  Suggested roles for OCCA materials development and support (primary roles in bold)

<table>
<thead>
<tr>
<th>Role</th>
<th>Description</th>
<th>Faculty/Dept</th>
<th>Central</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tutoring:</td>
<td>Reviewing &amp; marking student work.</td>
<td>Teachers, tutors</td>
<td>Central</td>
</tr>
<tr>
<td>Teaching:</td>
<td>Developing and delivering subject activities, class administration etc.</td>
<td>Teachers</td>
<td></td>
</tr>
<tr>
<td>Faculty/department IT coordination:</td>
<td>Organising staff training, IT &amp; teaching strategy.</td>
<td>Academic IT coordinator</td>
<td></td>
</tr>
<tr>
<td>Educational design:</td>
<td>Design and advice about learning strategy, educational requirements.</td>
<td>Teachers, designers</td>
<td>CDS, R&amp;ES</td>
</tr>
<tr>
<td>Evaluation:</td>
<td>Review &amp; dissemination of findings.</td>
<td>Teachers, local unit</td>
<td>R&amp;ES</td>
</tr>
<tr>
<td>Student support:</td>
<td>Hotline, reports of problems, registration, allocation in groups.</td>
<td>Teacher, local unit</td>
<td></td>
</tr>
<tr>
<td>Teacher support:</td>
<td>IT advice/training for teachers, development assistance, setting up activities.</td>
<td>Local IT unit, key teachers</td>
<td>LR</td>
</tr>
<tr>
<td>Site production:</td>
<td>Web page production in Dreamweaver etc.</td>
<td>Local IT unit</td>
<td>CDS</td>
</tr>
<tr>
<td>Development support:</td>
<td>Professional development, resources and advice.</td>
<td>Local IT unit</td>
<td>TeLaRS</td>
</tr>
<tr>
<td>Page programming:</td>
<td>Customised page functions (JavaScript).</td>
<td>Local IT unit</td>
<td>CDS</td>
</tr>
<tr>
<td>Multimedia programming:</td>
<td>Interactive objects or interfaces (Shockwave).</td>
<td>Local IT unit</td>
<td>CDS</td>
</tr>
<tr>
<td>Systems programming:</td>
<td>Server/database functionality (Java), administrotive functions.</td>
<td>Local IT unit</td>
<td></td>
</tr>
<tr>
<td>Systems administration:</td>
<td>Database maintenance, hotline support for localised support staff.</td>
<td>Local IT unit</td>
<td></td>
</tr>
<tr>
<td>Research &amp; development:</td>
<td>Ongoing exploration of new approaches, uptake and publications.</td>
<td>Teaching and support staff</td>
<td>R&amp;ES</td>
</tr>
<tr>
<td>Strategic management:</td>
<td>Coordination, funding, prioritisation, directions and support of OCCA central facility.</td>
<td>Teaching and support staff</td>
<td>CDE, LR, R&amp;ES</td>
</tr>
</tbody>
</table>

In addition, individuals may take on a range of roles. For example, a teacher may assume responsibility for educational design, evaluation, student support and site production. Allocation of technical roles will also reflect resources and skills available to departments and the Central Unit.

It is worth emphasising that within the projects examined in this chapter, central funding programs have tended to foster resource-intensive project approaches. This will change as centralised project funding is reduced and faculties take more direct responsibility for allocating priorities. That is, the picture emerging in this study needs to be interpreted in the context of a shifting culture of innovation. My interpretation of the situation is that departments will increasingly seek to engage as many teachers as possible in the on-going maintenance and development of course materials, which will include both traditional and CFL approaches. Further, the focus will shift from specialised course development projects to more routine materials development within local departments and units. It is within this scenario that I believe the ‘Departmental’ approach to the implementation of OCCA-based learning and teaching environments, supported by key services of the Central Unit, can continue to foster practical yet innovative approaches to transforming education.
10.5 Summary

In this chapter, production outcomes of the generic learning system development associated with Goal 1 of the study were reported in terms of the application of the software within particular curriculum settings. Two specific case studies were examined in detail and the wider uptake in the University surveyed.

The first case study described the use of the Online Courseware Component Architecture (OCCA) to support a curriculum innovation in Physiology. This project followed from previous attempts to use different technologies to solve identified teaching problems. OCCA learning activities were used to facilitate one component of a workshop-based Collaborative Learning Environment (CLE) in which students worked in groups on a topical problem over a semester (the ‘Group Project’). Other components of the CLE also used a number of previous iterations of the software developed within this study. Many educational constructs exemplifying the capacities of OCCA to support innovation in teaching resulted from this project, for example, student brainstorming, reflection, re-drafting, group work, peer review, ‘Editorial Board’ review and electronic learning portfolios. Teachers were also supported with optimised views of student work and feedback templates. Course evaluations indicated that the CLE environment was effective in improving learning outcomes, although the influence of particular components was difficult to determine. Teachers discovered new views of their students’ work.

A second case study was set within the Department of Learning and Educational Development in Education. This drew from the Physiology CLE model, with additions and refinements for the specific requirements of a vocationally orientated subject. Videos and images were used in many of the group and individual activities. Subject evaluation indicated that the OCCA-facilitated flexible learning environment was well received by students and provided timesavings to teachers once the site was created.

A survey of 25 separate projects across ten of the eleven faculties of the University revealed different approaches to the implementation of OCCA. Some teachers developed and maintained their own materials in an on-going manner with minimal support from the Central Unit. Collaborative involvement with teachers in this ‘departmental’ approach was the primary focus of this study. Many projects, however, were produced by Central Unit project teams on behalf of teachers, often involving additional interactive objects and specialised functions. Other approaches involved departments working with external developers, or some combination of the above.

The variation in development approach reflected different levels of working with OCCA, for example, programming system functionality, interactive objects or Web pages. Differences in the broad educational strategies were also noted, reflecting different emphases on the use of student reflection, authentic contexts, practice, self-assessment, review by teachers of student work and teaching administration. Fifteen potential roles necessary for the broad implementation and support of OCCA within the institution were suggested. Appropriate combinations of teachers, departmental support staff and Central Unit staff would depend on the particular project and the skills and resources available within a department.

This chapter concludes the report of outcomes of the first production goal. In the next chapter, the analysis of the workplace experience begins, with a narrative history of the development of the generic online learning system and the previous TutorialTools application.

11.1 Introduction

In the previous two chapters, the generic learning system and its implementation within the University were reported as outcomes of the first goal of the study. This chapter begins the focus on Goal 2, which was to develop deeper understanding of the workplace experience behind the software development. The history of events portrayed here is the first stage in the development of a grounded theory of that experience, which continues with a more detailed analysis in the following chapter. This is the personal ‘story’, drawn from diaries, reflective journals, emails, documents and software artefacts, captured in narrative form to convey the complexity of real life experience. The rationale and methods behind the narrative are elaborated in Chapter 8.

I have been deliberately concise in introducing this chapter, so as not to distract from the story by overlaying any additional interpretations, other than those inherent in the narration. Such a real life experience involves a complex and often unpredictable pattern of events and issues related to professional work, research activity,
politics and social interaction. Even though we might prefer to believe that activities such as CFL research and development can be undertaken in an objective manner, it is valuable to look past the more comfortable personal and community models to the messiness of real life. The purpose of this chapter is to represent that complexity, to some degree at least, in order to increase understanding of our community of practice and lay some foundations for its improvement.

The voice of the story is in the form of jottings and ‘ordinary’ language that might be found within a personal diary or email to a colleague. It necessarily must compromise between detail and readability and is intended to evoke a sense of the experience, rather than be an objective transcript of events. Individuals will read the story at different levels and from different perspectives according to their background and intentions. For example, technical detail might be skipped by one person but closely followed by another, depending on their respective interests or level of technical understanding. Unless otherwise noted, quoted phrases are taken from my journals and available documents to convey the flavour of my thinking at the time.

The narrative spans two periods, from 1991 to 1994, when I was working within a departmental setting in Chemistry and from 1996 to 2000, when I was working within the central Multimedia Education Unit (MEU). Key individuals figuring in the later period were PhD student Albert Ip (AI) and programmer Gangmeng Ji (GJ), who were MEU colleagues with parallel interests in online interactivity. Over much of the study the three of us engaged in deep discussion and debate that stimulated the development of ideas and solutions. Also of particular importance were collaborations with Dr Robert Kemm (RK) and Dr Helen Kavnoudias (HK) from the Department of Physiology, whose enthusiasm and ideas provided a vital educational underpinning to the study. Other specific contributors are referred to by name and in references to published papers (Section 7.7.4).

The story is structured under the seven principal development ‘phases’ described more fully in Sections 9.2.1 and 9.2.2. While this structure imposes a certain interpretation of events, I consider this a reasonable ‘trade-off’ for the benefit of cross-referencing within the thesis. Each phase is introduced with a contextual comment and key events are summarised in timeline. References to the event timeline made from other chapters refer to the closest (earlier) month and year, for example, ‘July 1998’. ‘Shockwave’ is a particularly common term referring to online objects programmed in Macromedia Director; other terms are clarified in the footnotes and in the glossary (Appendix 1, p. 263).

The reader may find it useful to refer to:

- Figure 11.19 (p. 188) – an overview of activity phases and technical approaches;
- Table 9.1 (p. 130) – a summary of principal features of the software within the different phases; and
- Figure 1.2 (p. 7) – an overview of the University infrastructure supporting CFL.

### 11.2 Departmental experience 1991–1994


In September 1991, I was employed in the School of Chemistry, having just negotiated a job title change, from Programmer to Instructional Designer. This was a time of major internal re-structuring that was affecting
everyone. Over the previous two years I had produced some small interactive HyperCard tutorials for the annual Open Day in my own time and developed a HyperCard lecture presentation application, used by a number of lecturers. I was now able to concentrate full time on supporting teachers with Computer-Aided Learning (CAL), which tied in nicely with the Graduate Diploma in Instructional Design I was just completing. The University was beginning to encourage departments to think about the use of computers in teaching and had set up a new central Interactive Multimedia Learning Unit (IMLU). IMLU had just announced the first seed funding program for innovative computer-based curriculum projects…

**Sep 1991:**
**First interest in CAL project**
Chasing up everyone I can find around the university looking for ideas on CAL. One group in Chemistry is interested. The idea is to develop an interactive program to simulate lab experiments to supplement practical classes – students would enter on-screen calculations and receive immediate feedback. Going for seed funding with this.

**Oct 1991:**
**First interactive simulations in Director**
Finally got a copy of the new Director application – means I can now start on interactive simulations. Tested it out by making a simple simulation to show students how not to use a pipette – the perfect application for it!

![Figure 11.2 Breaking pipette simulation](image)

**Successful funding application**
Seed funding application for $7500 was successful! Means we can employ a student to help with development of materials.

**Initial focus on simulations of laboratory equipment**
Have been working on a Director titration simulation over the last month – added sound effects, swishing water and drips. It’s elegant but fairly obvious the cost benefit ratio is low – we’ve decided to concentrate on simpler animations, images and on-screen videos of laboratory techniques with questions and immediate feedback. Apple’s new QuickTime technology will be useful!

![Figure 11.3 Titration simulation produced in Director](image)

**Nov 1991:**
**Three tutorials under development**
Starting to work on a couple of modules for some other teachers – I can copy the program code and question techniques from earlier programs. Applying the instructional design techniques from the course.

**Mar 1992:**
**Visual mapping of student activity**
Teachers have been looking at existing prac classes and videotaped students. I wrote a HyperCard program to track the video and generate visual maps of student activity (Fritze, 1994; Fritze & McNaught, 1996). Teachers really interested to see the dynamics of the prac classes displayed.

![Figure 11.4 Visual mapping of student activity](image)

**July 1992:**
**First CAL evaluations & trials**
Ran some trials of the CAL module in one of the computer labs – students prefer to get straight to the ‘tasks’, rather than exploring all the pages of theory and other resources we put in. Oh well.

I’m still catching up with people outside the department for ideas and to show what we

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4 The CAL group in Chemistry associated with TutorialTools was led by Dr Peter McTigue; in particular, I worked closely with Heather Grant and Dr Carmel McNaught (CSHE).
5 Macromedia Director: one of the first authoring programs for producing animations and simulations.
6 Apple QuickTime – the first technology to make possible on-screen videos.
are doing. The project was presented at an IMLU seminar. I’m not used to public speaking – relieved that it went down well. HOD impressed and discussed the formation of a new committee to promote CAL in School.

More student evaluation trials – video recording, think-aloud technique, log trails, interviews, etc. Working on another tutorial now and trying to design the instructional strategy – chemistry subject matter is really difficult for me. If I knew it once, I don’t now.

Aug 1992:
PUC conference in Japan

A major coup! My paper is accepted – I’ve got a fully paid trip to the Apple Pacific Universities Conference in Japan (Fritze, 1992). Fantastic!

Finished the Grad Dip finally, but continuing workload problems. No real enthusiasm displayed for my instructional design approaches.

Nov 1992:
Structure of tutorials falling into place

Design of the tutorials has been gradually refined. 10–15 question screens, simple navigation controls and various question formats. Student can drag items to complete statements, label pictures, assemble flow charts or select from multiple choices, enter numbers, text. Feedback via hints, explanations and complete solutions. Students can send comments to the teacher.

Figure 11.5 Early tutorial question

11.2.2 1993–1994: TutorialTools

Until late 1992 I had been working long hours developing question formats for each of the individual tutorials. At this point, I began extracting the common software code into a single ‘shell’ program. More or less by accident, I realised I could store the content material in the form of a ‘question script’ that was loaded into the tutorial shell when it started. I could set then up a tutorial by editing and compiling the ‘hidden’ data in the question script, and formatting the visible objects on the HyperCard screen. By this time we were approaching the start of semester and the first official running of the tutorials…

Jan 1993:
Very hard work preparing tutorials for classes

Lot of pressure now on all of us coming up to start of semester. I’m really frustrated that after all the work of the past year, only two tutorials look like being completed.

Major rethink of software approach – have decided to standardise the different question functions from the different tutorials into a common program – will let me set up different tutorials much more quickly. I’ve got three months prior to semester to do it.

Frantic activity – “putting all my effort here into building the question tools, rather than content. Working regularly until 1am.”

Feb 1993:
The concept of a tutorial authoring system emerges

Just dawned on me – this program is actually pretty significant. There is no reason why teachers can’t use these ‘authoring’ tools as well. Have decided to call the program ‘TutorialTools’. Teachers are getting concerned that the first module won’t be ready for semester and it’s hard to explain or justify what I am trying to do.

Figure 11.6 TutorialTools question – Tutor menu
<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mar 1993:</td>
<td>First CAL tutorial workshop runs successfully</td>
</tr>
<tr>
<td></td>
<td>Just managed to get the content into the authoring system a couple of days ago. Have just run the first ever tutorial to 14 students. I was really nervous about how the students would receive it, or even whether it would work at all with a large group! Most students had probably never used a computer before, even fewer a Mac. Some were absolutely petrified – had to point out to a few that the mouse (a) operated with the ball underneath and (b) not several inches above the bench. Absolutely elated afterwards!</td>
</tr>
<tr>
<td>Jun 1993:</td>
<td>Regular progress</td>
</tr>
<tr>
<td></td>
<td>Have been working hard to get a tutorial on Atomic Bonding out. We put some audio feedback into this, which caused a real commotion as the tutor’s voice popped up all over the lab. Worth a try I guess. I’m gradually refining the tutorial and authoring functions and working extremely hard, sometimes all night, to make sure the software is fully operational prior to classes. It’s fairly stressful and not helped by restructuring going on in the School. Not sure what my long-term future is here.</td>
</tr>
<tr>
<td>Aug 1993:</td>
<td>Eight new CAL tutorials completed</td>
</tr>
<tr>
<td></td>
<td>Over the past six months, we’ve put together eight modules run to 1200 first year students – content written by lecturers, authoring in TutorialTools generally by a post grad student and a few other teachers. Just keeping up on a week-by-week basis.</td>
</tr>
<tr>
<td></td>
<td>AUC conference</td>
</tr>
<tr>
<td></td>
<td>Ran a hands-on workshop on TutorialTools for the University and gave another paper at the Apple Consortium Conference in New Zealand (Fritze, 1993). Interest from other institutions – have organised a licence agreement for them to use it.</td>
</tr>
<tr>
<td></td>
<td>Outside interest</td>
</tr>
<tr>
<td></td>
<td>Major CAUT grant awarded, pressure before going on leave</td>
</tr>
<tr>
<td></td>
<td>Great news! – success with a major CAUT grant (McTigue, Tregloan, Fritze et al., 1994). Frantic activity leading up to long service leave in September – under pressure to finish off documentation and fix various bugs.</td>
</tr>
<tr>
<td>Jan 1994:</td>
<td>Uncertainty over my position, conflicting priorities</td>
</tr>
<tr>
<td></td>
<td>Back from three months leave. Feeling more uncertain now and actively looking for a way out. I want to continue to refine and extend the program but this is meeting with resistance. Teaching staff concerned that the software is ‘finished off’ and fully documented. Clear also I’m no longer required to produce or run the tutorials.</td>
</tr>
<tr>
<td>Mar 1994:</td>
<td>Seconded to IMLU</td>
</tr>
<tr>
<td></td>
<td>Some good news – I’ve been seconded to work in IMLU for three days a week. Part time work continues in Chemistry – small changes to the program, documenting, supporting users, etc. Chemistry managed to get funding for a new CAL lab of 40 computers – looks very impressive!</td>
</tr>
<tr>
<td>Jun 1994:</td>
<td>APITITE and IFIP conferences</td>
</tr>
<tr>
<td></td>
<td>Gave paper at the APITITE conference on the development and evaluation process (Fritze &amp; McNaught, 1994). I’ve extended the visual mapping approach to track students’ use of the tutorials – presented this in a paper at IFIP conference (Fritze, 1994). Quite pleased with this! Got a glimpse of this new Web thing people are starting to talk about.</td>
</tr>
<tr>
<td>Nov 1994:</td>
<td>Demonstrated TT running with the Web</td>
</tr>
<tr>
<td></td>
<td>End of year retreat for the CAL group to plan the future of the Chemistry CAL program. I showed how the HyperCard tutorials could be started from links in a Web page.</td>
</tr>
</tbody>
</table>

7 VCBTA: Victorian Computer-Based Training Association.
8 CAUT: National Committee for the Advancement of University Teaching – ran major funding program for teaching initiatives in higher education.
During 1994, 39 different CAL modules were run to some 1500 first year students. TutorialTools remained in extensive use until 1999, when the module content was transferred into a Shockwave version of the tutorial system, independently developed by the School of Chemistry (Coller & Tregloan, 2001). Documentation of the TutorialTools software was completed by a retired academic over a period of six months. At the end of 1994, I obtained a full time position at IMLU, leaving Chemistry after 15 years, unannounced.

11.3 Central Unit experience 1996–2000

11.3.1 1996–7: Tutorial Engines

The story second begins in 1996, when I was working as an educational developer in the Multimedia Education Unit (MEU) at the University of Melbourne. Until this time, using the Web to deliver highly interactive learning tasks, equivalent to those in independent multimedia programs, simply was not technically possible. The release of ‘Shockwave’ meant sophisticated interactive applications, animations and simulations could be delivered in the online environment. This provided the first real opportunity to convert the TutorialTools program into a Web-based format in a project titled ‘Tutorial Engines’ (TE), although this had been an intention of mine since 1994...

Apr 1996: Extended negotiations with university staff on possibilities

Actively chasing up colleagues, CSHE staff, teachers and any others I can find – sussing out ideas for building Web-based software. Have been playing with Shockwave and using examples to demo the possibilities. Chemistry staff interested in an online version of TutorialTools. Not sure exactly what form this will take.

Jun 1996: Early vision of Web-based learning framework

Sketching out a broad framework for developing and delivering online learning resources across the University – to be fleshed out in pilot projects from different disciplines:
• interactive learning elements: questions, visualisations, simulations etc.
• Web page templates
• server tools for logging student work
• ways to connect Web pages, elements and central services

First pilot project using interactive online quiz

Suggested to the Library they port the earlier HyperCard module to a Shockwave quiz (Jones & Fritze, 1996). Will tie in with TutorialTools style questions, hints, criteria, feedback etc. Questions set in ‘question script’ file edited by library staff.

Jul 1996: EdTech 96 conference

Prototype library online quiz has two question types – basic multiple choice and ‘select correct word’ in passage (Figure 11.7). Demo’d it at the EdTech 96 conference (Fritze, 1996b) – also ran workshop on use of Shockwave. Finally enrolled in PhD at La Trobe Uni!

Figure 11.7 Library interactive quiz object running in a Web page

9 MEU was moved from the Faculty of Education to the Information Division in 1999 and became part of the Teaching, Learning and Research Support department during restructuring of the Division in December 2000.
Sep 1996: MEU adopts TE project

Faculty TE trials

Nov 1996: Detailed specification drawn up

Dec 1996: QRM conference

Jan 1997: Experimenting with prototype course deliver system

Feb 1997: First inter-component communication

Mar 1997: Continuing development of various interface objects

Continuing to push the idea of an online framework. Adopted by MEU managers as the 'Tutorial Engines' project – a take on TutorialTools. “I see TE as a key project to be integrated into the MEU support, research and product agenda”. Many debates with AI and GJ on approaches and techniques. Still chasing contacts in faculties – set up a couple of trial sites for teachers. Word must be getting around – asked by the DVC (IT) for an overview!

Technical and functional overview now drawn up. See TE as more than just a tutorial system – a whole framework of components, protocols and infrastructure support “extending the opportunities for rich and constructive learning activities… evaluation methodologies and support for materials development, collaboration and staff development.” The new round of talmet10 project grants a fantastic opportunity – sure I can get involved in some ‘key projects’ based on they prototypes I’ve been working on.

‘Qualitative Research Methods’ conference (Fritze, 1996a) – bit of an eye-opener. Really useful for articulating and documenting project ideas and fits with PhD study.

Experimenting with a course delivery prototype using HyperCard and AppleScript – good-natured competition with AI over the best approach! Have to say I failed dismally – runs much too slowly and I loose the bet. GJ is now assisting me with other database methods. This approach will be able to deliver a whole online course – tutorials, questions, feedback, the lot! Using ‘question scripts’ to specify content – really like this approach I use in a lot of my programming.

Have set up a TE Web site to push ideas out – “a framework to support the implementation of Web-based tutorial-style learning activities within the University”.

Have realised that the fixed size Shockwave objects will be a problem for different content. I’ve broken the Quiz Shockwave object into smaller objects. Managed to get them to communicate with a ‘quick and dirty’ technique supported in the new release of Shockwave. A bit rough but fine for demos!

Old Chemistry tutorials proving a great source of content examples. Loved building a periodic table interface object to run with the Quiz (Figure 11.8) – really neat!

Enjoying this kind of exploratory prototyping. This concept map should be another good demo interface (Figure 11.9). Transferred more Chemistry tutorial questions. Thinking about a graph input interface after talking to old mates in Chemistry. Exploring OOP11 techniques in Shockwave for first time – interesting!

Figure 11.8 Periodic table and quiz objects interacting in Web page

Figure 11.9 Concept map interface object

10 talmet: common abbreviation for T&L(M&ET), the Teaching and Learning, Multimedia and Educational Technology Committee at the University of Melbourne.
Apr 1997:
Quiz object now has most features of TutorialTools

Continuing to pack features into Quiz object: questions progressively revealed, hints, explanations, rubber stamps, variety of question types – close now to original TutorialTools, but in a Web page!

Figure 11.10 Quiz object approximating most features of TutorialTools

Discover MelbourneIT are developing a course system.

Just found out that MelbourneIT\(^{12}\) has been developing an online course delivery system! MEU Director has arranged a meeting to suss this out and explore possibilities for collaboration. Really hope my work isn’t redundant. “Working to 2 & 3 over several nights” to prepare for meeting – need to show really good demos.

Graph Sketcher interface object programmed using object-oriented structure

Will use the Graph Sketcher as a good example. Idea is that students ‘sketch’ a graph in response to a question and get feedback from the Quiz object, which can read the style, starting point and ending point of the curve. Working really hard but enjoy this type of work. Using the OOP software technique.

Figure 11.11 Early Graph Sketcher used in MelbourneIT demo

MEU negotiating with MelbourneIT

Meeting with MelbourneIT went well – they see our work as complementary and we’ve agreed to explore possibilities for collaboration.

11.3.2 1997–8: Learning Engines

It was a bit of a shock suddenly becoming aware of commercial learning management systems. I realised there was little point in trying to compete, but rich interactivity on the Web didn’t seem to be well supported, or understood. I continued to make contact with teachers and explore ways of increasing online interactivity, although the software design approach had significantly changed, even if this was not visually apparent. Until now, the online technique depended on a single Quiz object configured by a ‘question script’ connecting with specialised interface objects (e.g. Figure 11.8). The Quiz object was now evolving into a more sophisticated multi-purpose ‘tool kit’, containing increasing numbers of internal sub-components. The object assembled itself on delivery according to instructions in a separate question script. The basic shell could be transformed into practically anything, for example, a block of questions with feedback, or interface objects such as a concept map, Graph Sketcher or image construction tool. This period coincides with a project name change to ‘Learning Engines’ (LE), reflecting a more ‘politically correct’ vision of learning materials. This master ‘LE object’ emerged out of the Graph Sketcher software...

Apr 1997:
Work on prototype interface objects assembled within LE object

OOP approach in the Graph Sketcher worked well – should “dramatically increase the efficiency of creating future interactive objects”. Have re-engineered it into the first version of a master ‘Learning Engine’ object, taking functions from the Quiz object. Added more sub-objects to support concept maps and ‘drag & drop’ questions. Simple script specifies how the bits are assembled (Figure 11.12). Working now on interfaces for the Chinese language project.

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\(^{11}\) OOP (Object Oriented Programming): a software approach using independent functional blocks of code that have defined attributes (e.g. width, colour) and internal methods (e.g. draw, reset).

\(^{12}\) MelbourneIT is a commercial arm of the University.
Script (left) configures a ‘Palette’ containing four ‘Chinese’ characters that can be dragged into an initially empty ‘Sentence’ object.

Packing more into LE object – now over 30 sub-objects including containers (paper, palettes, sentence, map), tools (graph pen, move, sound, resize tools) and parts (character, concept, arrow, message, image, text field). Script determines visible structure of object on Web page. Very powerful! The beauty is that the current state of the object can be described, e.g. the contents of a ‘Sentence’, or a ‘Plot’ drawn in a ‘Graph’, and read by the Quiz object. Even better, the state of the object can be preset simply by passing it the description in script format.

David Kennedy (DK) has been researching faculty requirements for graphs, which I have now incorporated into Graph Sketcher. Added axes, capacity for multiple plots – comes naturally because of OOP structure. DK evaluating use in curriculum trials (Kennedy & Fritze, 1998; Kennedy et al., 1997a; Kennedy et al., 1997b).

Further meetings with MelbourneIT re use of LE components in CREATOR\(^\text{13}\). Likely it will be adopted across the University – Chemistry already signed up. Lots of politics involved. Speaking of which, the vigorous discussion and debate with AI continues around our parallel approaches. Finally have agreed to merge some of our ideas. Some ownership issues but I am pleased.

Continuing to push the LE message through seminars and consulting with teachers. Talmet grants\(^\text{14}\) announced – successful LE-based projects in Physiology, English, Genetics and History – very pleased! Demo’d number of prototype interactive objects in Dentistry, Vet Science, Chinese, Chemistry at the ASCILITE conference (Fritze & McTigue, 1997; Ip et al., 1997; Kennedy et al., 1997b).

Increasing project work and starting to feel the pressure – “working to 2am or 3am for many nights”. Staff roles and responsibilities not clear – desperately need programming support. Doing interesting work, however, with teachers from Economics and Commerce, English and Physiology on open-ended LE questioning sequences – student gives initial response before self-assessing this against an expert answer (Fritze et al., 1998).

Becoming increasingly concerned about complexity of LE programming. Simply don’t have enough time and “wonder how long I can keep it up”. Part time programmer working on ‘drag and drop’ object not effective as LE software requires full time effort to master. Very frustrating. One department has reverted to old version before class deadline – a major relief! I’ve been investigating with AI the use of XML as a protocol for the Question Script format. Taking this on means more intense work. Taken far longer than expected. Software bugs in Shockwave “cost me many days extra hard work” – infuriating. Delays in meeting project deadlines. Extremely stressful for me and for teachers depending on me. RK is “happy with my objects and wants to support them – but has stuck his neck out”. Doing all I can.

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\(^{13}\) CREATOR: name of MelbourneIT’s learning delivery system (originally called CMILE).

\(^{14}\) T&L(M&ET) grants: The Teaching and Learning, Multimedia and Educational Technology Committee awarded $1M in competitive grants for curriculum innovations in 1997.
July 1998:  
Rethinking dependence on Director  
Came across the simple text entry and ‘drag and drop’ activities GJ created with DHTML in quite basic Web pages. Realise that this is simpler, although less powerful, than trying to get sub-objects to render in Shockwave. Anyway, programming support finally approved to complete the LE software. Recent work with Physiology teachers also making me realise that the “view of the teacher may be different” to my interpretations, which have been focused on technical structures and algorithms.

Aug 1998:  
First meeting of MOCCA group  
Emergence of ‘State Description’ protocol  
MEU staff meeting to define mission for the ‘Melbourne Online Courseware Component Architecture’ project (MOCCA). Aim is to combine my work with AI’s and GJ’s in a common MEU approach. I’ve adopted the term ‘State Description’ of an object. Refers to a standard protocol for recording and interpreting the current state of objects – actually a means of representing ‘student work’.

CREATOR launched  
CREATOR finally launched! A major media event addressed by the Federal Minister of Education and the Melbourne Vice Chancellor. Lots of glitz, even stage smoke – wonder about the mirrors. Amused to see my old pipette simulation (Figure 11.2) featured as the (only) example of ‘interactive’ content. Twenty programmers have been working fulltime on this. VC cautious about the future.

Sept 1998:  
Problems come to a head  
Various problems continuing to plague the LE project. Generic software too difficult for the contract programmer – costs me time, rather than saving it. Too much on my plate with external professional commitments, projects, software development and study. The limited size of Shockwave objects has become a real problem for one Arts subject requiring large amount of text. I think practicality of Shockwave is at the limit.

MelbourneIT just announced (quietly) there would be no further development on CREATOR. Truly amazing! Hoped-for sales did not occur – Chemistry will have to revert to TutorialTools. Feeling pretty smug!

Decision to use Web pages controlled by a LE object as the question interface  
“By making awkward requests for functions and clearly not content to accept what ever I can give” one of the tutors in Physiology has “triggered a complete rethink that resonates with the discussions with GJ over the use of external windows and HTML elements”. My idea is to use LE to generate and manage Web pages, rather than Shockwave objects. The state of these pages is read and set by this manager object, which provides feedback to students. Greatly simplifies coding! GJ’s DHTML objects can be incorporated and all current project requirements are met – “amazed and excited at how quickly this technical restructure fell into place”.

11.3.3 1998–9: Activity Manager

By October 1998, the focus of development had shifted to the notion of a structured learning ‘activity’ as a sequence of Web pages managed by a master Shockwave object. The ‘Learning Engines’ object was transformed into the ‘Activity Manager’ (AM) that could dynamically write these pages to a second browser window to create a progressive sequence of related questions. The Activity Manager could read students’ responses for each page, offer hints or explanations and move to the next question, according to an XML script defined by the teacher. While the generic ‘Learning Engine’ object remained and could still used as an interface object within these question pages, the emphasis was shifting to basic Web pages and simplified shockwave interface objects.

15 DHTML: way of creating moveable layers in Web page. With JavaScript, this can be used to create reasonably interactivity within a page.
16 The acronym MOCCA suggested by Dr Ric Canale, who was also involved with group negotiations.
“The impact on staff just dawns on me. [The teachers] can put together clusters of screens to make up an activity in a simple [Web page] editor and this data can be patched into the [Activity Manager] by way of an XML doc. They can use images, links etc and be any size. Input elements can be any HTML elements. Brilliant!”

Oct 1998:
Intense work adapting to the use of JavaScript for the Activity Manager

Working “regularly to 2 and 3am” to convert the LE object to the “Activity Manager” for projects in Genetics and Physiology to demo at DITAM 17. Using XML script to hold the HTML for each activity page, as well as hints, feedback etc. The Web pages use pretty complicated JavaScript to talk to each other – this programming is “new to me and ... neither easy nor bullet proof”. GJ providing key parts of the coding. Simply no time for journal 18 entries for the last month – finding it “difficult to switch” my mind between programming and writing.

Prototype Activity Manager operating

Question page written by AM

Feedback window generated by AM responding to input on page

Buttons step through question pages

AM Shockwave object loads first

Figure 11.13 Prototype Activity Manager writes question page and provides feedback after checking entries against criteria specified in XML

State Description Protocol adapted to describe student work in Web pages and interactive objects

‘State Description Protocol’ evolving into the key means of describing student work – uses JavaScript object notation 19 worked out with GJ. The AM reads the state of objects on Web page or sets it to an ‘SDP’ value as required. Graph Sketcher stripped of unnecessary code and made SDP compatible.

Figure 11.14 Graph Sketcher controlled by the AM

Nov 1998:
DITAM presentation of prototype activities in Physiology and Genetics

Increasing functionality to maintain local histories of student work and dynamically map progress

Demonstrated AM at DITAM – “intricate learning interactions approaching that of the face-to-face experience, customisable interfaces to discipline knowledge, responsive feedback in a variety of formats and strategies for open-ended or subjective knowledge areas”. Educational model being driven by work with Genetics and Physiology. AM now stores history of student work and progress, but no connection to a central database yet. Interesting extension requested by RK for an ‘activity Map’ summarising students’ progress across different questions (Figure 11.15). ‘Jigsaw pieces’ are filled in as items are completed. Will require significant thinking to handle extended student work but I believe I can do it!

Figure 11.15 Prototype Physiology activity map

17 DITAM: Doing IT at Melbourne – major annual internal conference event organised by MEU.
18 Reflective journal maintained as part of action research study.
Jan 1999:

**Director update**

New version of Director just arrived – I don’t have the time but have to test the new Web and XML features to see if they’re relevant.

**MOCCA group attempting to define mission of research focus**

MOCCA group ‘mapping session’ – after skirting around this for months we “lay down our cards and discuss” a generalised development architecture for MEU.

Results in an agreement to pull a number of existing technologies together – specifically the research work of GJ, AI and me (Fritze & Ip, 1998; Ip & Fritze, 1998b; Ji et al., 1998).

**Investigating running activities in TopClass**

Demo AM to people from WBT Systems to sound out possibility of AM activities operating within TopClass\(^{20}\) – seem willing to help.

**Research grant application**

Helped with joint submission ARC submission for research into cognitive tools for reflective learning. AM approach would allow recall of student answers for reflection and annotation, with summaries of progress, overview maps for both student and teacher. Continuing discussions with teachers related to new round of Talmet funding applications for 1999. Invited as observer on Talmet committee – great!

**Successful projects**

Seven LE/MOCCA projects funded this year! Most referring to the AM to provide feedback for learning activities, plus a few Shockwave interfaces required.

**Difficult programming work and pressure to complete projects for first semester**

Intensive work to 2, 3 or 4am on Physiology extensions. “Extreme difficulty... working across development environments... very time and mentally consuming”. Faculty staff stressed. Work by the contract programmer on interface objects slow.

I’m beginning to wonder now about this dependence on AM, as it’s now technically possible for simple HTML pages to save and restore their states independently.

Don’t think I can meet deadline – extremely stressed and working across “too many levels”.

Feb 1999:

**Abandoning Shockwave Activity Manager**

A month of frantic work, crisis meetings. Now forced to conclude that relying on Shockwave as a central controller is problematic due to the fundamentally poor connection between it and the browser. Simply nothing more I can do. Physiology teachers have decided to produce a regular multimedia module and use original LE components for some areas.

“I have reached the conclusion that there are continuing problematic issues with the use of Shockwave in a browser environment as the major ‘engine’. It would appear that with the current development strategy, I cannot see convergence occurring. The use of Shockwave as the main development environment does not represent the best approach from this point on – although it was probably the only way in which the ideas could have developed in the first place...”

11.3.4 1999–2000: OCCA client-side

In February 1999, the model for a generic online learning system had been turned on its head. Rather than a single manager object controlling sophisticated sequences of interactions and feedback, the focus had now shifted to independent HTML pages. The State Description Protocol remained central to the process of recording and processing the state of each page, which could contain any combination of forms elements and/or conforming interactive objects. The core set of JavaScript and Java applets\(^{21}\) embedded in each page will be critical and require a team approach to development.

“it is now an issue of the MEU team arriving at common agreement on a specification and management plan for such a framework, if it is to go anywhere at all. I cannot, working within this set of individually

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\(^{19}\) JavaScript object notation: a Javascript format for specifying a nested object structure.

\(^{20}\) TopClass commercial course management system by WBT Systems, used in Faculty of Medicine.

\(^{21}\) Java applets: primarily refers her to objects programmed in ‘Java’ attached to a Web page.
complex and overlapping technical environments, allow myself to give assurances to things that are clearly beyond my individual capacity to carry out.”

March 1999:
National funding proposal
MOCCA becomes OCCA

MEU has just submitted a CUTSD\textsuperscript{22} application with U. of Wollongong – “OCCA\textsuperscript{23}: an Online Courseware Component Architecture for improving interactivity of academics’ courseware design”. Negotiating this “has been very important to put the issue on the table” at MEU. OCCA now shaping as “a set of small client- and server-side components connected by common protocols, rather than any centralised software system”. It’s all about customised interactive interfaces, reflective & open-ended questions, overviews of the student learning by student and teacher. State Description Protocol is the key, capturing ‘snapshots’ of interactive Web pages saved and restored using generic Java applets and JavaScript code on each page.

OCCA Web site set up

Have set up an OCCA Website to demo educational functions. Presented seminar at Monash University. While I have faith in what I am doing, I suspect it is less relevant to them as a practical solution.

May 1999:
OCCA negotiations

MEU Director has formulated an agreement between AI and me over the origins and mission OCCA as a combined MEU approach. Negotiations touchy.

Aug 1999:
14 OCCA projects under development
Letting go of close involvement
OCCA programmer appointed

Moving away from close involvement with OCCA technical development, but new round of funding proposals means talks with teachers in Music, Optometry, Horticulture, Architecture, Computer Science and Engineering. Disappointing when only interest is in immediate feedback – don’t always share my enthusiasm for more reflective learning activities! Fourteen curriculum projects now involve OCCA, Somewhat at a loss over my role. OCCA programmer appointed – enormous relief but mixed feelings about reduced role. Project manager now organises project meetings with teaching staff – starting to appreciate different aspects of project involvement, rather than taking on responsibility for everything. Finding it hard to let go. Conflicting demands on software development priorities – immediate project requirements balanced vs. longer-term strategic development.

Tom Reeves seminar
Collaborative research proposal with teachers

Interesting seminar by Tom Reeves calling for greater ‘use-inspired’ research. In line with a research grant application I just put in with six academic staff – proposes an action research approach to implementing projects, reflecting on the experience, students’ perceptions, views of work, etc. Thinking about a ‘Collaborative Development and Implementation’ model.

OCCA moved to Linux

Major amount of work by MEU staff on OCCA – GJ switches it to a more heavy-duty Linux system. All server-side work being done by GJ or contract programmer. Core JavaScript and Java applets for OCCA Web pages being refined. Slow progress – a string of problems. Not much I can do to help. Instability on different browser platforms – client-side scripts re-worked time and again. Wonder if problems will ever be resolved.

MEU seminar on CourseBuilder/OCCA

Macromedia have just released ‘CourseBuilder’ – would appear that teachers can create interactive tutorial Web pages using Dreamweaver as an authoring tool. Spent a week exploring significance of this and ran seminar for MEU staff to promote idea that interactive Web sites can be managed by teachers – would impact on MEU services. Push out a paper documenting OCCA with GJ and teacher from History – important to recognise the contribution of faculty and technical staff to the formation of the framework (Fritze \textit{et al.}, 2000).

Physiology Group Project

‘Group project’ with RK and HK in Physiology is interesting. Students work in groups in a ‘Collaborative Learning Environment’ exploring a topical problem over the semester. Previous implementation in TopClass was awkward to administer and use. HK and I worked on it just before semester.

\textsuperscript{22}CUTSD – Committee for University Teaching and Staff Development
\textsuperscript{23}OCCA – Online Courseware Component Architecture. The ‘M’ for Melbourne removed in the National interest.
Exciting progress! We can think about the face-to-face situation and fashion really good activities out of OCCA pages on the fly. “Can’t stop ideas coming. Feeling of control as I can do the small amount of programming required to explore ideas”.

**Mar 2000:**
- **OCCA core script problems**
- **Concept of learning portfolio emerges**

Managing pressure of work better – simply accept I can’t do everything. Technical problems with database connection in the early Physiology workshops. Extremely frustrating. HK and I are developing workshop pages week-by-week, building from previous one. Touch and go, but fascinating. We realised the summary pages of weekly work are actually a student ‘portfolio’ containing their drafts, confidence levels and comments to tutor. Changed wording on the pages to reflect this – e.g. to save work ‘in your portfolio’. Often over at the CLE lab – fascinating to see the group dynamics and key role of tutor in facilitating the student experience.

![Figure 11.16 Student portfolio containing summary views of learning](image)

**April 2000:**
- **Problems deepen with OCCA client-side projects**
- **Novel pedagogical functions emerge in adversity**

MEU staff experiencing major problems in other projects trying to support different browsers and platforms. Complex JavaScript pages, Java applets and authentication systems causing many interacting problems. Test trials don’t pick up all the possible configurations of user systems. Couldn’t wait for a server report function to be written so I constructed a simple administration page to view pages of individual students and provide feedback. Effect is fantastic! Displays rich views of the students’ work. Teachers immediately picked up and debated unexpected issues with students’ responses.

![Figure 11.17 Tutor feedback template](image)

**May 2000:**
- **Gaining confidence**
- **New educational terminology emerging**
- **History essay submission project starts**

Week-by-week collaborative work on Group Project really exciting. Sense of crafting experiences for students out of the basic OOCA functionality. Not enough time to fully explore and refine as much as we want though... We’re developing a teaching terminology – ‘learning portfolios’, ‘brainstorming’, ‘drafting’, self-assessment, ‘peer review’, ‘discussion frameworks’, ‘confidence indicators’, ‘comments to the tutor’ and ‘organising key concepts’. “Brilliant”.

**June 2000:**
- **EdMedia 2000 conference and visit to North America**
- **‘Collaborative Developmental Research’ model**

Gaining confidence in the educational significance of OCCA! Initiating discussions with educational units, faculty teachers and programming staff and other institutions. See OCCA now providing low-level ‘learning transactions’ to support online environments for reflective learning, open-ended questioning, self-assessment, peer review and teaching practice. Presented papers with RK at EdMedia on ‘Mass Customisation of Online Learning’ and Collaborative Learning Environments in Physiology (Fritze & Kemm, 2000; Kemm, Kavnoudias, Weaver et al., 2000). Really pleased to be able to contribute to these two perspectives. Discussions at conference and during visits to McGill, Toronto, Michigan, UBC helping me articulate my ideas – very positive feedback. Someone suggested it was rather ‘subversive’ – take that as a great compliment! The concept of ‘Collaborative Developmental Research’ of increasing interest to me – underpins the current collaborative experience with teachers and emphasises the interdependence of systems, educational perspectives and outcomes.
**July 2000:**

**Explorer limitation forces dropping of Java applet**

We can no longer support only Netscape – but this raises a fundamental technological problem. No practical way for Java applets or Shockwave objects to communicate with Microsoft Explorer on a Macintosh. Programmers have decided to replace Java applet with standard Web ‘POST’ operation through a special page, but keep the core JavaScript code. Still experiencing problems with different browser combinations – a circular process of testing, identifying problem, fixing and re-testing. Standardisation, which should reduce duplication of effort, is greatly complicating the work of the programmers and project managers. Have to say it would be a lot simpler to undertake these projects independently.

**Aug 2000:**

**Physiology Group Project in Semester 2**

HK and I continuing to adapt the Physiology workshop in semester 2. The timetable page now much more elegant – with icons for completed work and tutor comments. Tutors use a template page to annotate student work from the previous week. Extremely pleased with the way it’s working.

![Figure 11.18 Physiology main student activity timetable](image)

**Major change as client-side JavaScript is dropped in favour of server-side equivalents**

GJ has set up a ‘server-side’ process for restoring data from the database into a Web page for his ‘Suitcase’ project. Opens the possibility of removing all JavaScript from Web pages and using the standard Web ‘POST’ to submit data to database. Educational transactions essentially the same but all the active components can be run in a single stable server environment, rather than at the users’ computer. Shockwave objects could still post directly to the OCCA database. This is the way to go – a MAJOR relief!

### 11.3.5 2000–present: OCCA server-side

At this point, my direct involvement with OCCA system development further reduced, as GJ extended the server functionality to process Web pages prior to delivery to the user. This meant that the problematic JavaScript code could be removed from the pages, making them equivalent to regular Web pages. By this time, MEU had been incorporated into the TeLaRS department of the new Information Division. I was within the Research and Evaluation Services unit and away from Courseware Development Services (CDS), where most project development was undertaken.

I had also completed the action research component of the study, although I continued to maintain an interest and involvement in OCCA projects in Physiology and new ones in Education (see Chapter 10). These were ‘departmentally focused’ projects (Section 10.4.1), where teachers assumed the primary role of developing and maintaining OCCA materials for their particular requirements, with minimum assistance from the Central Unit. Of particular interest was the Interactive Learning Kit (ILK) project, funded in 2002 by T&L(M&ET) as a University ‘Generic’ project. This aimed to develop Web templates, educational exemplars and professional development resources for wider use within the University.

Numbers of OCCA projects have been taken on or continued by the CDS, involving teams of educational designers, programmers, project managers and graphic designers. These have involved more rigorous project
management processes, starting with a comprehensive ‘Software Specification Requirements’ contract. A smaller number of projects have been produced by departments themselves.

CDS programmers have undertaken a continuous revision of the OCCA server software, which now forms one component of the ‘NEO’ suite of educational tools, along side the ‘Quokka’ question authoring and delivery system, ‘Briefcase’ document management system and ‘Forion’ online discussion forum. The nature of current OCCA projects is summarised in Section 10.4.

From my own perspective, my involvement with OCCA is decreasing as I focus on other areas of research and educational support. The future of OCCA now depends on many factors, including support and ‘packaging’ by TeLaRS, the availability of other educational tools and systems, and its perceived usefulness by teachers, beyond the current adopters, in a pressured teaching and research environment.

11.4 Alternative perspectives on the development history

The above narrative history represents an interpretation of the workplace experience portrayed primarily through my eyes, using available empirical data. To refine and broaden this interpretation and to elicit alternative perspectives, the narrative was reviewed by a number of academic project collaborators, colleagues, management staff and family members, who have contributed to different aspects of the story in various ways, or have had a particular interest in the situation. The interviews with individuals were informal and open-ended, focusing on the broad questions as outlined in Section 8.4.6, p. 121. Feedback was sought from the following individuals:

Dr Angela Bridgland: Director, Teaching, Learning and Research Support Department.
Dr Ric Canale: Head, Courseware Development Services.
Victoria Fritze: Wife, secondary and tertiary teacher.
Professor Peter Harris: Chair, T&L(M&ET) Committee.
Dr Helen Kavnoudias: Academic teaching staff, Department of Physiology.
Dr Robert Kemm: Academic teaching staff, Department of Physiology.
Professor Carmel McNaught: Centre for Learning Enhancement And Research, Chinese University of Hong Kong, previously Centre for the Study of Higher Education, University of Melbourne.
Associate Professor Peter McTigue: Teaching academic, School of Chemistry, then Director of MEU, 1996–2000.

In the following sections comments triggered by the story are organised under the broad stakeholder categories of ‘academic collaborators’, workplace colleagues’, ‘university management staff’ and ‘family’. Naturally enough, each individual’s connection with the development varied substantially over the period 1991–2000. For example, an individual may have originally worked as a colleague, but later moved to a management role or
away from the University altogether. I have therefore grouped the observations according to the stakeholder perspective they appeared to represent, rather than to a specific individual. Direct quotes have been used to maintain the original sense of meaning as far as possible.

11.4.1 Academic collaborators

Academic collaborators are faculty teachers with whom I worked closely on curriculum projects within the study. They appreciated seeing the development history of the tools they had used, although perhaps felt the story did not really point out “what the lessons are”.

Academic collaborators are driven by a desire to improve teaching: “having to deliver to students is what matters”. Creating a framework for “rich student interactions” involved a continuous process of choosing approaches and having a “variety of tools being developed”. This was “difficult to do without corporate support” and here T&L(M&ET) and earlier funding programs were seen as the main drivers in the process.

Often, they were “forced into using things”, as there was simply “nothing else available” to achieve the desired result. The eclectic adoption of software created difficulties. For example, in Physiology, various versions of TutorialTools, Learning Engines objects and OCCA remain important components of courses, but each year their operation is questioned as Web browsers and systems move on. It is “disappointing” that the developers of these tools cannot provide ongoing support for their products.

Academic innovators appeared to respond to demonstrations I gave of new ICT approaches (“Wow!”) and could immediately see the potential for their teaching requirements. They were, however, selecting from a whole raft of possible approaches, including paper-based teaching activities, doing CFL development work themselves, or working with faculty or central educational production facilities, departmental developers, or external contractors. Their need for long-term support, design ambiguity and mutual respect often seemed at odds with production-orientated services of the educational units: “top-down design is a disaster”.

They made clear the frustration associated with trying to be innovative in their teaching. It was, for example, a “continuous process of moving to the next level of frustration”; that “some bunny has to do it”. Academic collaborators were involved very much with the departmental and faculty politics, but sensed a lack of support and acknowledgement for their efforts and some degree of marginalisation: the “politics was more challenging than Shockwave or Java”; and managers and support units “can’t see the practical problem on the other side” or “impact of what you are doing”.

11.4.2 Colleagues

Colleagues were other academics, programmers or PhD students working within the same unit (the Multimedia Education Unit from 1996–2000), from whom I sought advice or collaborated with in different projects. To them, the narrative brought back a “lot of memories” of the discussions, “dead ends” and details of the “technical exploration” that are “hard to re-create”. The comment was made that the real “leading edge” nature of the research process did not fully come across, but also that I had the advantage of being able to reconstruct the story from records in a way not possible for others.
The intense discussion and turning over of ideas occurring between the MEU colleagues was appreciated and fondly remembered, even when it sometimes raised issues of intellectual ownership. This type of research and development appears to be a “personal thing” and something that is difficult to force.

It was good to see that OCCA has “weathered the storm” and is still in active use within TeLaRS – a “robust test” of the viability of the idea. Previous versions of software were also seen to have a lasting effect, for example, the School of Chemistry is still “showing students the [TutorialTools] instructional design of 1992”, although the technical implementation is different and people seemed “happy to forget how it started”. “You can’t hold on to the [Intellectual Property] on ideas, which is unfair. IP is valuable, but you can’t tie it up”.

The problematic nature of the client-side version of OCCA and the torturous business of supporting different browsers and systems were re-called. The associated complexity and reliability problems were things “we just could not anticipate at the time”. People “felt bad about” programmers who bore the brunt of technology and whose best efforts were made redundant when a new approach was adopted. Technically, the Activity Manager approach was thought to be “too complex”, and somewhat embarrassing looking back. With hindsight, it is easy to say “why didn’t we simply start with the final solution?” but this is “unfair”. For these developments, it was not as simple as starting with an initial analysis of requirements, which can “take years” to understand. The “way you work is impacted on by technology” and even then things “never work as you think – there’s always that bit that is not right and is too hard to change”.

While the outcomes of both regular research and curriculum production are generally recognised; innovative research and development is not seen for the contribution it makes; “what you get in return for work is little”. It is “difficult to suggest how an organisation should handle this [innovative development]”, and while the “role of the team is critical”, it is “not always possible to put together the perfect team” – it requires “self-awareness”.

11.4.3 Managers

Management staff included directors of the Central Unit and others involved in the University or faculty CFL policy-making process. There was some concern that the narrative representation was too subjective, talking around rather than addressing real issues. It also did not comment on “cost effectiveness” of the production, an issue no one seems to fully address. Those not closely connected with the history, found the detailed story about the origins of the OCCA software “extremely informative” and contrasted this with other information sources. The manner in which the development was based on a very “personal teaching experience”; the significance of the current server-side version of OCCA; and different contributors were all noted. The crucial role of the database design and the State Description Protocol within OCCA “didn’t come across”.

The process of innovation and research, while interesting, needs to be looked at in the light of the current situation and resources. We have “moved forward” so that now the “University is a different place”, the “workplace group is different” and this type of development wouldn’t necessarily “transpose to the new environment”. Some believed that some degree of innovation was necessary to drive investigation of emerging technologies, although it was not clear who’s role this was. There was a need for a percentage of “blue sky research and development”, which if not supported by the institution, had to be eventually bought from somewhere else. The University, however, as a responsibility and opportunity to do this – it can’t afford to “only
evaluate”. On reflection, T&L(M&ET) funding programs turned out to be a “democratic process” – competitive, up front and available to anyone, with most faculties benefiting. The surge in innovation now needed to be consolidated and the momentum preserved. The focus by the University on ICT seemed to provide a “common language” across disciplines that fostered discussion of other issues of educational policy.

The distinction between research and production was noted. “Research and development” was at the cutting edge of design, while production does not have the “experimental component”. This should have been “put on the table” within curriculum projects, although it was recognised that these aspects can’t always be separated. What starts off as straightforward production may well veer off into problematic areas. At the same time, it was hard to pick the features that made projects successful. It was a “percentage game” and there seemed to be a process of “bio-diversity and natural selection” operating. The problematic nature of working with technology was noted: “riding the tiger”; the “nuts and bolts” work; and the impact of working “till 3am each night on technology A, then along comes technology B”. Pushing the boundaries of CFL was a “painful struggle” and it took a “driven” person to take an idea through to “fruition”. We might learn something about the innovation process from these work habits, but it was unclear whether these represented a “virtue” or a “penalty”.

OCCA has had “a lot of influence”, with “many academics coming in contact with it”, even if it is “not easy to identify what that is”. It is one tool used by TeLaRS that has “helped to focus faculties on innovation in ICT, rather than on simply transmitting materials, even if the technology behind the developments remained “invisible” to teachers. OCCA appeared to provide “interesting” support for learning models, such as small group tutorials.

11.4.4 Family

I made an initial decision to omit details of family from the narrative history for understandable reasons. In the process of reflection, however, it was clear that my family not only provided an important support role, but also were impacted on by the workplace situation. They are truly stakeholders in the process and if I am to maintain my stated openness in the inquiry, they certainly have a right to voice their perspectives.

In reflecting on the story with family members, there was clear concern with the representation of the emotional aspects in the story. It was a “sanitised” version, which they felt underplayed the emotional “roller coaster”, the intense working to deadlines and the distress caused by periods of departmental re-structuring. This impacted on them; however, the excitement I experienced with any progress or success in the workplace did not. They pointed out the different “stories” at home and at work. At home I would unload my frustrations and stress, while at work, it appeared that I was non-confrontational, diplomatic and would not “rock the boat”. Positive aspects of the story stood out, but they had to live through the “negative aspects”. They felt that “important aspects of the development process outside the formal conception of the workplace” needed to be acknowledged. For example, the “sounding board qualities of the wife don’t come across.” My personal and professional drive had a clear impact on family life. For example, my plea that I would “have to work really hard just for the next two weeks” became a standing joke. It was also noted that critical personal support I received from particular individuals at certain stages, like that from the family, did not come across within the history.
The impacts of my ‘workplace’ activity on my family varied. My older daughter, who was ten in 1991, remembered the impact of departmental restructuring at this time. People she knew as family friends ‘mysteriously disappeared’ in a way she could not understand, in a situation that appeared out of her father’s control. (This early period in departmental history affected many people and in no way reflects on any person referred to within this study). As a fifth year university student now, she critically questions the genuine openness of my grounded inquiry.

In an alternative view, my younger daughter, aged seven in 1991, saw the situation as perfectly “normal”. The ‘Ramona’ books provided a reassuring family model of a father losing his job and retraining (Cleary & Tiegren, 1977). All parents did a lot of work at home and fell asleep in front of the television, or when reading the children a story at night. She heard parents talk but “it didn’t make sense” and just “assumed everything would be OK”. When she did recognise that families did not all fit the same mould, having a father who “stays up all night” became something of a “claim to fame” among her friends. I cannot resist including the story she wrote between 1991 and 1992 of the “man who lived in a computer” (Appendix 6, p. 285). It is a unique commentary on the workplace situation that is the subject of this study. As a second year university student now, she will regularly still be working at her studies after I have gone to bed.

A summary of comments attributed to the different stakeholder perspectives is organised in Table 11.1 (see p. 187), under themes of the narrative representation, research and development process, collaboration, product under development, organisation and technology. It suggests that academic collaborators, as innovators in education, were driven by their desire to improve their teaching with whatever resources were available, but saw their situation within the institution as somewhat problematic. Colleagues in the Central Unit focused on issues of development and were conscious of the difficult nature of leading edge ICT development. Managers appeared interested in broader institutional views of corporate history and the relationship of the research process to regular production. Finally, family members revealed a different perspective on the workplace situation that links workplace and family experience that did indeed influence research and production outcomes.

This analysis of alternative views of the CFL innovation process represents only the first stage of what could be a wider investigation into perceptions of stakeholders building on the ‘relational model of university learning, teaching and support’ (Section 6.5). It indicates that stakeholders have quite different perceptions that reflect their particular situations. Further, the process of reflecting on an historical narrative has exposed a range of individuals to such alternative perspectives, in manner that has fostered discussion and acknowledgement of different positions within a broader context. Such alternative perspectives have informed the synthesis of an organisational model of Collaborative Developmental Research in Section 13.2 pitched at those ‘outside’ the innovation process.
### Table 11.1 Summary of alternative perspectives on the workplace experience

<table>
<thead>
<tr>
<th>Representation</th>
<th>Academic collaborators</th>
<th>Colleagues</th>
<th>Managers</th>
<th>Family</th>
</tr>
</thead>
</table>


| Collaboration | Pragmatic choice of providers, tools and collaborators to solve teaching needs. Require understanding and flexibility. | Critical nature of available team. Perfect team not always possible. “R&D is a very personal thing”. | Contributions of different individuals noted. | Observed how always a few people would “keep me going and interested”. |

| Product | Leading edge. Trying to create rich learning interactions. “great idea, potential, exciting”. | Leading edge R&D. Pleased product taken up by others. Not easy to identify what OCCA is. | “Can’t be developed again – the world has moved on”. OCCA has influenced a lot of projects – often unseen. Supports small group tutorial model. | |

| Organisation | Frustration, marginalisation. Trying to fit innovation into the department. Difficult without corporate support. Support units want to impose their own processes. | Innovation an unseen component of production. | Need to distinguish between R&D and production. Alternative view of institutional history. T&L(M&ET) funding a “democratic process” that now needs to be consolidated. University has a responsibility and opportunity to undertake R&D – cannot simply undertake evaluation only. A “percentage game”. | Job security issues. “have no respect for hierarchy, formalities or structures”. Work is a way for me to “do what I want” – fortunate to have survived economic rationalisation so far. |


### 11.5 Overview of project phases and technologies

Figure 11.19 maps the relationship between software developments and technologies referred to in the narrative. The main focus is on the action research period of this study from 1996 to 2000 and my earlier work in Chemistry between 1991 and 1994. The main development phases (Figure 11.19) that underpin the structure of the narrative are contained within the dotted rectangles. Arrows and overlapping areas indicate a direct connection between different software designs. For example, ‘TutorialTools’, became the initial model for ‘Tutorial Engines’ and also influenced further ChemCAL developments in Chemistry. ‘CREATOR’ was a
course management product developed by MelbourneIT, a commercial arm of the University, while the ‘Suitcase’ curriculum project for Law directly contributed to the server-side version of OCCA through the work of Gangmeng Ji. The continued use of TutorialTools, Learning Engines and OCCA following their development is indicated.

Figure 11.19 Relationship between software developments and technologies within the study

11.6 Summary
This chapter has provided a narrative description of two significant case studies of CFL Systems Development, spanning nine years of enormous change in the use of technology in education. This was created from a comprehensive analysis of data drawn from contemporary documentation, communications, reflective journals and software artefacts. The narrative is intended to evoke a sense of the personal workplace experience, but is certain to be interpreted in different ways, according to the background and interests of the reader. It is structured around seven main phases in the software developments, identified in the grounded analysis of Chapter 12. These phases refer to periods of my work within a departmental setting between 1991–4 and a Central Unit between 1996 and 2000 and correspond to particular versions of software under development. The phases provide a means of cross-referencing between components of the analysis in other chapters. This narrative history provides a foundation for further grounded analysis of emerging dimensions of the workplace experience in the following chapter.

The narrative history was reviewed by other stakeholders in the University as a means of not only verifying the content, but also bringing to the fore alternative perspectives on the situation. Comments made in interviews were organised under stakeholder categories of academic collaborators, colleagues, managers and family. As roles and relationship to the CFL development often overlapped and changed over the years, the comments were attributed to stakeholder categories, rather than particular individuals. Comments made by family place a new
light on what should be considered as the scope of the ‘workplace’ under examination. The alternative perspectives revealed will inform the development of an organisational model of innovation in Chapter 13.

In the following chapter, further grounded analysis of the case study data reveals patterns of activity within the workplace experience that are illustrated by reference to the narrative history.
CHAPTER 12.  A grounded analysis of the workplace experience

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12.1 Introduction

This chapter further examines phenomena emerging from the workplace experience associated with the CFL systems development of TutorialTools (1991–4) and OCCA (1996–2000). This is an integrative analysis that builds on the raw dimensions emerging from the process of data collection, categorisation, visualisation and narrative description outlined in Section 8.4.

A Classification Framework of key categories and dimensions drawn from these initial data provides a framework for the analysis. As with the narrative history in the previous chapter, the analysis is structured around the major ‘phases’ of software development across the two case studies. Occurrence of the dimensions and their relationships are quantified and emerging patterns are investigated in relation to the narrative history. This deconstruction of the workplace experience is organised under categories of personal dimensions, CFL development activities, organisation interactions and community involvement.
Finally, a Developer-centred Innovation Model is generated from the evidence emerging from the analysis. While clearly set in the context of the particular case studies examined, its applicability to other settings can be gauged by consideration of the rich contextual descriptions undertaken in the study. This model provides the foundations for an organisational perspective on the innovation process, to be examined in chapter 13.

12.2 Dimensions of the workplace experience of CFL Systems Development

The derivation of the raw properties and dimensions of the workplace experience is described in Section 8.4. In summary, evidence was catalogued under individual records in the research database and tentative descriptive dimensions were assigned. As this process of data gathering and coding continued, the dimensions were organised under broader property definitions and iteratively refined, extended and re-applied to previous records. The records were repeatedly ‘combed’ and consolidated in parallel with the visualisation of data and writing of the narrative history (Sections 8.4.4, 0 and 8.4.6). The end product was a reasonably stable set of raw properties and dimensions, describing and relating workplace emerging phenomena. The raw properties at this stage included ‘actions’, ‘feelings’, ‘links’, ‘connections’, ‘project’, ‘software’ and ‘technology’, as defined in Table 8.4 (p. 115) and Appendix 5 (p. 283).

12.2.1 A Classification Framework for the workplace experience

To further investigate relationships between the workplace phenomena, particular dimensions from the raw grounded classification were re-examined. These were re-grouped into 32 new dimensions, ordered under categories of ‘Reflective practice’, ‘CFL development’, ‘Organisation’ and ‘Community’. The re-ordering represents an extension of the initial grounded analysis, which also draws on perspectives arising in the literature review (Chapters 4 to 7).

The resulting strategic ‘Classification Framework’ for the workplace experience, as defined in Table 12.1 (see p. 192), is the foundation of the statistical analysis of workplace phenomena in this chapter. The classification of 502 records used in the analysis for the periods 1991–4 and 1999–2000 is summarised in Table 12.1. Here N is the number of records referring to a given dimension. For example, in 18 out of 502 records I reported being ‘stressed’. EventDays is calculated from the ‘Date’, ‘EndDate’ and ‘Weighting’ properties (Table 8.4, p. 115) and ‘EventDays%’ refers to the likelihood of a given dimension being reported on any workday and adjusts for records referring to extended periods:

\[
\text{EventDays} = (\text{EndDate} - \text{Date} + 1) \times \text{Weighting}
\]

\[
\text{EventDays\%} = \frac{\text{EventDays} \times 100}{\text{TotalDays}}
\]

Weighting is a scaling factor assigned to each record to account for less than fulltime impact (defaults to 1). For example, a record representing programming activity over 28 days, might be given a Weighting factor of 0.43 to signify the activity occurred at the rate of three days per week. A weighting of 1.00 would indicate the work continued over weekends. ‘TotalDays’ is 1791, being the estimated number of workdays over the periods 3/9/91–3/11/94 and 3/3/96–18/8/2000. Thus the evidence in Table 12.1 suggests there was a 23% chance of ‘Overwork’ being reported on any particular workday within the case study period periods.
Table 12.1 Classification Framework of workplace experience 1991–2000

<table>
<thead>
<tr>
<th>Category</th>
<th>Dimensions</th>
<th>Nature of my experience</th>
<th>N</th>
<th>Event Days%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personal</td>
<td>Stressed</td>
<td>Work pressure causing stress</td>
<td>18</td>
<td>4%</td>
</tr>
<tr>
<td></td>
<td>Overwork</td>
<td>Well past regular working hours</td>
<td>42</td>
<td>23%</td>
</tr>
<tr>
<td></td>
<td>Concerned</td>
<td>Workplace concern or disappointment</td>
<td>52</td>
<td>3%</td>
</tr>
<tr>
<td></td>
<td>Interest</td>
<td>Evidence of interest</td>
<td>34</td>
<td>8%</td>
</tr>
<tr>
<td></td>
<td>Pleased</td>
<td>Evidence of pleasure</td>
<td>28</td>
<td>2%</td>
</tr>
<tr>
<td></td>
<td>Excited</td>
<td>Demonstration of a sense of excitement</td>
<td>37</td>
<td>8%</td>
</tr>
<tr>
<td>Reflective practice</td>
<td>Investigate</td>
<td>Inquiring into a particular issue</td>
<td>33</td>
<td>6%</td>
</tr>
<tr>
<td></td>
<td>Reflect</td>
<td>Purposeful reflection on events and</td>
<td>53</td>
<td>3%</td>
</tr>
<tr>
<td></td>
<td>Rethink</td>
<td>strategies via written journals, meetings</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Reconceptualise</td>
<td>A major revelation, or paradigm shift in</td>
<td>26</td>
<td>5%</td>
</tr>
<tr>
<td></td>
<td>Write</td>
<td>understanding of a situation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reflective practice</td>
<td>Plan</td>
<td>Map out plans</td>
<td>29</td>
<td>5%</td>
</tr>
<tr>
<td></td>
<td>ID</td>
<td>Tasks of instructional design</td>
<td>18</td>
<td>12%</td>
</tr>
<tr>
<td></td>
<td>Program</td>
<td>Writing software programs</td>
<td>72</td>
<td>38%</td>
</tr>
<tr>
<td></td>
<td>Implement</td>
<td>Involvement in running course materials</td>
<td>19</td>
<td>9%</td>
</tr>
<tr>
<td></td>
<td>Evaluate</td>
<td>Engage in formal evaluation process</td>
<td>8</td>
<td>0.5%</td>
</tr>
<tr>
<td></td>
<td>Document</td>
<td>Carry out process of documentation</td>
<td>23</td>
<td>4%</td>
</tr>
<tr>
<td>Organisational action</td>
<td>Consultation</td>
<td>Provide advice to teaching staff</td>
<td>42</td>
<td>9%</td>
</tr>
<tr>
<td></td>
<td>Discuss</td>
<td>Discussions with others</td>
<td>32</td>
<td>2%</td>
</tr>
<tr>
<td></td>
<td>Negotiate</td>
<td>Resolve issue through negotiation</td>
<td>17</td>
<td>1%</td>
</tr>
<tr>
<td></td>
<td>Promote</td>
<td>Activities promoting interests of the</td>
<td>42</td>
<td>3%</td>
</tr>
<tr>
<td></td>
<td>Funding</td>
<td>Activities involved in seeking funding</td>
<td>25</td>
<td>2%</td>
</tr>
<tr>
<td></td>
<td>Collaborate</td>
<td>Work on equal footing with others</td>
<td>51</td>
<td>12%</td>
</tr>
<tr>
<td>Community</td>
<td>Individual and groups associated with workplace activity or event</td>
<td>Colleague</td>
<td>Staff member of my work unit</td>
<td>87</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Academic</td>
<td>Academic member of a faculty</td>
<td>122</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Project team</td>
<td>A formally set up project team</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Students</td>
<td>Students involved in use of development</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Uni unit</td>
<td>The central education unit in the</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Uni management</td>
<td>University management staff</td>
<td>29</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ext academic</td>
<td>Academic staff of other universities</td>
<td>43</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ext company</td>
<td>An external company</td>
<td>14</td>
</tr>
</tbody>
</table>

N = number of records, EventDays% = probability of dimension being reported on any workday.

The distribution (N) of records according to its dimensions is charted in Figure 12.2 (see p. 193), showing variation across the phases. (Dimension labels here and in later charts display only the first eight characters of the terms in Table 12.1. References to dimensions will be written in expanded form and placed in italics). From Figure 12.2 it can be seen that Community contacts with academics or colleagues are reported in over 200 records, with programming the most commonly reported CFL development activity, referred to in some 70 records. These were most numerous in the Learning Engines (LE) phase, while contacts with academics were most common during the OCCA (client-side) and LE phases.

Figure 12.3 (see p. 194), on the other hand, indicates the total number of days associated with each dimension, that is, EventDays. From this measure, programming activity is the most common daily activity, reported in nearly 700 days spread consistently over all the phases, with overwork associated with some 400 days.
This quantification of workplace phenomena must be acknowledged as being somewhat subjective. It is intended to provide a representation of workplace experience that, while not drawn from a precise day-by-day account of events, might reveal patterns and relationships that can be corroborated by other evidence, such as the narrative history and visual maps. The nature and extent of evidence also varied over the cases. For example, there were substantially fewer entries within the earlier phases. The interpretation of events depended on my specific knowledge and understanding of the situation. Finally, the various dimensions represent fundamentally different phenomena, such as extended activities, incidents, relationships or feelings that can only be compared in a
subjective manner. Nonetheless this analysis represents a best attempt to draw meaning from the evidence of an extended and authentic workplace experience.

Figure 12.3 ‘EventDays’ for each dimension and phase (total workdays = 1791).

12.2.2 Correlation between dimensions

Cross correlation provides a further method for exploring relationships between dimensions within the Classification Framework. While correlations are useful for discovering possible relationships between dimensions, causal links cannot be assumed. For example, the originating factor within a given relationship cannot be identified, and additional hidden factors may also affect the relationship (Heiman, 1998, p. 243). A correlation may also have more to do with the assumptions behind dimension definitions. For example, an
apparent relationship between two dimensions may be the result of overlapping meaning, while ambiguous definitions will tend to weaken relationships.

Full Pearson correlations of the Classification Framework dimensions are tabled in Appendix 10 (p. 297). This is based on the number of records (N), rather than EventDays, to preserve the detail within individual records. I am interested here in correlations between dimensions simultaneously reported on the same record. This addresses the reality that a single record of (say) programming activity representing an extended period cannot adequately represent the day-to-day variation in other dimensions and hence will tend to swamp correlations of single event data.

Significant positive correlations are summarised in Table 12.2 (see p. 196), with correlated dimensions listed in descending order of Pearson correlation significant at the 0.01 level. For example, this reveals strong positive correlations for overwork with programming (0.451) and stress (0.29). There is a high correlation also between evaluation and the student community, although this involves only a handful of records (Table 12.1).

The most significant negative correlations between dimensions are summarised in Table 12.3 (see p. 197). Negative relationships appear less informative, but suggest that dimensions such as programming and reflection refer to singular activities, not often reported in combination with others. Negative correlation between academics and colleagues suggests that three-way meetings were not common.

The correlations are further explored in the following section. Even where the revealed relationships are relatively weak, they can offer clues for effects not readily apparent within other representations, such as the narrative history, visual maps or distribution charts. The quality of these relationships will, in the end, only be verified by corroboration with other evidence.
Table 12.2  Positive correlations between record dimensions (N) significant at the 0.01 level (2–tailed)

<table>
<thead>
<tr>
<th>Personal</th>
<th>stressed</th>
<th>overwork(0.29), program(0.166), discuss(0.081), students(0.077), implemen(0.074),</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>overwork</td>
<td>program(0.451), stressed(0.29), implemen(0.091),</td>
<td></td>
</tr>
<tr>
<td></td>
<td>concern</td>
<td>reflect(0.287), negotiat(0.189), collegau(0.173), rethink(0.133), discuss(0.099), projectt(0.077),</td>
<td></td>
</tr>
<tr>
<td></td>
<td>interest</td>
<td>investig(0.184), reconcep(0.116), extacade(0.116), discuss(0.092), write(0.084), program(0.071),</td>
<td></td>
</tr>
<tr>
<td></td>
<td>pleased</td>
<td>negotiat(0.146), extacade(0.112),</td>
<td></td>
</tr>
<tr>
<td></td>
<td>excited</td>
<td>reconcep(0.312), evaluate(0.147), students(0.109), collabor(0.107), implemen(0.104), academic(0.071),</td>
<td></td>
</tr>
<tr>
<td>Reflective</td>
<td>investig</td>
<td>interest(0.184), collegau(0.176), rethink(0.161), discuss(0.095),</td>
<td></td>
</tr>
<tr>
<td>Practice</td>
<td>reflect</td>
<td>concern(0.287),</td>
<td></td>
</tr>
<tr>
<td></td>
<td>rethink</td>
<td>collegau(0.185), investig(0.161), concern(0.133),</td>
<td></td>
</tr>
<tr>
<td></td>
<td>reconcep</td>
<td>excited(0.312), interest(0.116),</td>
<td></td>
</tr>
<tr>
<td></td>
<td>write</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>present</td>
<td>extacade(0.306), write(0.284), academic(0.086),</td>
<td></td>
</tr>
<tr>
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<td>plan</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>program</td>
<td>overwork(0.451), stressed(0.166), id(0.104), interest(0.071),</td>
<td></td>
</tr>
<tr>
<td></td>
<td>implemen</td>
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</tr>
<tr>
<td></td>
<td>evaluate</td>
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<td></td>
</tr>
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<td></td>
</tr>
<tr>
<td></td>
<td>discuss</td>
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<td></td>
</tr>
<tr>
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<td>concern(0.189), collegau(0.147), pleased(0.146), plan(0.095), collabor(0.083),</td>
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</tr>
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<td>promote</td>
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<tr>
<td></td>
<td>funding</td>
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<td></td>
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<td></td>
<td>collabor</td>
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</tr>
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<td>Community</td>
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<td></td>
</tr>
<tr>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>projectt</td>
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</tr>
<tr>
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<td></td>
</tr>
<tr>
<td></td>
<td>uniunit</td>
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</tr>
<tr>
<td></td>
<td>unimgt</td>
<td>discuss(0.145), plan(0.085),</td>
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</tr>
<tr>
<td></td>
<td>extacade</td>
<td>write(0.323), present(0.306), interest(0.116), pleased(0.112), collabor(0.109),</td>
<td></td>
</tr>
<tr>
<td></td>
<td>extcompa</td>
<td>promote(0.124), collabor(0.103),</td>
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</tbody>
</table>
Table 12.3  Negative correlations between record dimensions (N) significant at the 0.01 level (2-tailed)

<table>
<thead>
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<th>Personal</th>
<th>Reflective practice</th>
<th>CTL Development</th>
<th>Organisation</th>
<th>Community</th>
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</thead>
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<td>Stressed</td>
<td>Overwork</td>
<td>Concerned</td>
<td>Investig</td>
<td>Reflect</td>
</tr>
<tr>
<td></td>
<td>promote(-0.091), colleagu(-0.081)</td>
<td>academic(-0.132), program(-0.12), collabor(-0.114), extacade(-0.104), excited(-0.096), interest(-0.092), promote(-0.079), consult(-0.079), write(-0.078)</td>
<td>consult(-0.08), present(-0.068)</td>
<td>consult(-0.141), extacade(-0.125), promot(-0.124), concern(-0.12), discuss(-0.107), consult(-0.103), unimgt(-0.101), plan(-0.101), funding(-0.094), write(-0.094), ununit(-0.086), collabor(-0.081), negotiat(-0.077), academic(-0.073)</td>
</tr>
<tr>
<td>Interest</td>
<td>Pleased</td>
<td>Excited</td>
<td>Reflect</td>
<td>Present</td>
</tr>
<tr>
<td></td>
<td>concern(-0.092), colleagu(-0.082)</td>
<td>concern(-0.096)</td>
<td>extacade(-0.07), promote(-0.069)</td>
<td>colleagu(-0.117), reflect(-0.088), collabor(-0.086), investig(-0.068)</td>
</tr>
<tr>
<td>Investig</td>
<td>Reflect</td>
<td>Write</td>
<td>Consult</td>
<td>Colleague</td>
</tr>
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<td></td>
<td>consult(-0.08), present(-0.068)</td>
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<td>colleagu(-0.138), reflect(-0.104), program(-0.103), promote(-0.091), investig(-0.08), discuss(-0.079), concern(-0.079), collabor(-0.078), unimgt(-0.075), plan(-0.075), reconcep(-0.071), write(-0.069)</td>
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</tr>
<tr>
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<td>Write</td>
<td>Evaluate</td>
<td>Discuss</td>
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<td>reflect(-0.075), collabor(-0.074)</td>
<td>program(-0.107), consult(-0.079)</td>
<td>colleagu(-0.174), extacade(-0.14), concern(-0.132), write(-0.108), project(-0.105), unimgt(-0.1), extcompa(-0.096), reflect(-0.089), plan(-0.081), program(-0.073)</td>
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<tr>
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<td>colleagu(-0.105), colleagu(-0.103), reflect(-0.077), extacade(-0.069)</td>
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<tr>
<td>Plan</td>
<td>Reflect</td>
<td>Implement</td>
<td>Negotiat</td>
<td>Students</td>
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<td></td>
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<td>Colleague</td>
<td>Promote</td>
<td>Unimigt</td>
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<tr>
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<td>Extacade</td>
</tr>
<tr>
<td></td>
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<td>academic(-0.14), program(-0.125), reflect(-0.105), concern(-0.104), colleagu(-0.103), reconcep(-0.072), rethink(-0.07), project(-0.069)</td>
</tr>
<tr>
<td>Colleague</td>
<td>Academic</td>
<td>Extcompa</td>
<td>Students</td>
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<td></td>
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<td>academic(-0.096), colleagu(-0.078), program(-0.069)</td>
</tr>
</tbody>
</table>
12.3 Deconstruction of the workplace experience of development

In this section, another representation of the workplace experience is generated. Like the narrative history in Chapter 11, this representation is largely descriptive in form, but here the experience is deconstructed through a detailed examination of dimensions emerging in the grounded analysis. This is an integrative analysis (Section 8.4.7) that draws together previous descriptive and quantitative evidence from the Classification Framework (Section 12.2.1), correlations between dimensions (Section 12.2.2) and narrative history (Chapter 11).

The following sections are organised under the broad Classification Framework categories, with charts of ‘EventDays’ representing the incidence of dimensions across phases. References to dimensions are in italics and links to the narrative timeline are in the form ‘(May 1998)’. Positive correlations between dimensions (Table 12.2) are used to underpin the discussion, which then draws on other evidence, including direct quotes from the narrative history or original data sources. The six phases of the development referred to are (Section 9.2.1):

- CAL and TutorialTools – historical data related to my development of a tutorial application within a departmental setting between 1991 and 1994; and
- TutorialEngines (TE), Learning Engines (LE), Activity Manager (AM) and OCCA(Client-side) – the action research component of this study to develop a generic online learning system between 1996 and 2000.

12.3.1 Personal dimensions

References to my personal feelings were apparent in all phases (Figure 12.4). For example, times of stress were noted in reflective statements, such as “waking up at night worrying over problems”, or that “there is too much on my plate”. These appear most strongly connected with project or presentation deadlines and are clearly correlated with periods of overwork. Particularly stressful times occurred prior to the implementation of class tutorials in the TutorialTools phase and when I was attempting to finish software developments in the LE stage (May 1998). An additional source of stress in the TutorialTools phase related to departmental re-structuring, when my role in the department was undergoing significant change (Jan 1994).

![Figure 12.4 Dimensions associated with personal feelings in terms of ‘EventDays’ across all phases](image)

*Figure 12.4 Dimensions associated with personal feelings in terms of ‘EventDays’ across all phases*
Overwork is a dominant personal factor in every phase (Figure 12.4) and is strongly correlated with programming activity (Jan 1993, Jan 1998). It was characterised by such reflections as “increasingly frantic period of activity for 3 months” or “intensive late nights to 2, 3, 4am for many nights”. This was often in an effort to meet project deadlines and was associated with stress. It is significant that overwork was the most commonly noted reflection on my personal situation, occurring in 23% of ‘EventDays’ between 1991 and 2000. Intense periods of development in TutorialTools to “prepare for classes in first week” continued with other tutorials throughout the semester. The nature of the workload changed over time. For example, it could be traced to the frantic attempt to deal with complexity of software objects in the Learning Engines phase (Jan 1998). By contrast, overwork during the OCCA phase involved “week by week” development and implementation (Mar 2000), but significantly, exhibited little of the stress associated with the TutorialTools and LE phases. That is, overwork is not necessarily linked to stress and indeed, may well be associated with pleasure and excitement.

A broad range of issues were of more general concern, such as “difficulty of working across development environments”, “failing with deadline” or when “too many things… vie for time”. Concern was evident in negotiations with management over “restructuring” or “recognition of my role & position” in TutorialTools and LE phases. Intellectual property ‘ownership’ concerns also surfaced in the LE phase. I was often disappointed by the failure of technologies to live up to their promise, even after intense effort, and when academics appeared (to me) not to exploit the full potential of a software development.

Balancing the negative dimensions were positive feelings, such as interest, being pleased or even excited. My interest was typically aroused when I investigated new techniques and technologies, met with different people (particularly those outside the workplace), or attended demonstrations of products or techniques new to me. Beginning new projects also generated a sense of interest. Pleasure was associated with progress in projects, seeing my designs taken up or giving successful presentations. Receiving acknowledgement or recognition also appears a cause for pleasure. Extending beyond this was the sense of excitement. This was strongly correlated with reconceptualisation of my understanding caused by major breakthroughs in a development or a sudden revelation of the significance of a new approach. In earlier years, giving presentations, successful grant proposals, or seeing the first successful implementation of projects, were causes for very positive feelings. It is worth noting that the most ‘successful’ outcomes in terms of delivering effective teaching solutions were in TutorialTools and OCCA, which were also associated with the highest positive feelings. Thus despite a fairly constant amount of effort (as indicated by overwork), the returns for effort appeared to vary dramatically across the six phases, although some degree of excitement and interest is present at every stage.

12.3.2 Reflective practice

Activities associated with the adoption of a reflective approach to development practice included investigation, which was a purposeful exploration of technical or educational strategies (Figure 12.5). It was correlated with personal interest and, unlike other production activities, was not bound by curriculum requirements or deadlines. Investigative activity was most evident in the initial stages of the two case studies. For example, in the CAL phase, I first sought out academics and other staff “looking for ideas” and to investigate possibilities for CAL development (Sep 1991). This understanding then underpinned the TutorialTools phase, during which little investigative activity occurred. The commencement of the online development in the TE phase was also marked by a comprehensive investigation of approaches (Apr 1996). These involved discussions with colleagues and
academics and “experimenting” with software approaches. Software investigation often involved building prototypes and “testing” of new software releases.

In addition to technical exploration, investigation also involved “looking for ideas”, “seeking the views of academics” or “exploring possibilities for collaboration”. This occurred through active discussion with colleagues, faculty academics and others within the university or at other institutions. This is most apparent in the OCCA phase, for example, when I investigated models for “reflective practice” and “reflective teaching environments” (Jun 2000).

Reflection is correlated with personal concern, influenced particularly by problematic issues in the LE phase. Maintenance of a reflective journal was time consuming, as evidenced in the AM phase when “extreme concentration of work in a new development area … means I haven’t keep the journal going over the last month” (Oct 1998). During the OCCA phase, however, a richer form of collaborative reflection with academics developed in a productive curriculum development cycle (May 2000).

It would appear that reflection on practice is implicit in many other activities, for example, the act of writing enabled me to explore personal understandings. I noted that it helped form a “bridging language to link technology, developers and academics to discuss issues of learning”. Reflection appeared to be triggered by “problems, presentations, communicating with others, technical serendipity, action research reflection”. I noted that is was an implicit part of “writing a paper, a presentation, mentor communications, seminar, and purposeful evaluation”. That is, the reflection as defined within the Classification Framework probably under represents the process implicit within many general activities.

A broader definition of reflection on workplace situations might therefore be associated with reported activities, such as:

Figure 12.5 Dimensions associated with the process of reflective practice (‘EventDays’)

In addition to technical exploration, investigation also involved “looking for ideas”, “seeking the views of academics” or “exploring possibilities for collaboration”. This occurred through active discussion with colleagues, faculty academics and others within the university or at other institutions. This is most apparent in the OCCA phase, for example, when I investigated models for “reflective practice” and “reflective teaching environments” (Jun 2000).

Reflection is correlated with personal concern, influenced particularly by problematic issues in the LE phase. Maintenance of a reflective journal was time consuming, as evidenced in the AM phase when “extreme concentration of work in a new development area … means I haven’t keep the journal going over the last month” (Oct 1998). During the OCCA phase, however, a richer form of collaborative reflection with academics developed in a productive curriculum development cycle (May 2000).

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A broader definition of reflection on workplace situations might therefore be associated with reported activities, such as:
• formal workplace appraisal meetings with management staff involving discussion of my progress, role and future plans;
• formal reviews of project progress and strategies, for example, in project meetings or the formal TutorialTools stakeholders ‘retreat’ (Nov 1994);
• one aspect of the action research undertaken in this study, in particular in LE and OCCA; and
• informal discussions between myself and colleagues or academics to “discuss progress” and “new possibilities emerging”.

_Rethinking_ describes my adjustment to a strategy and was associated with _investigative_ activities and discussions with _colleagues_. This dimension only emerged in the formal part of the study from evidence in reflective diary and journal entries. _Rethinking_ often referred to a change in technical direction, for example, exploration of different technologies in the early TE phase. A typical reflective comment indicates this technical problem-solving aspect: “after a lot of soul-searching … we have decided to re-vamp the component operation to work in Java. There are too many problematic links brought in with Shockwave connecting to the browser”. Educational design also underwent a process of continuous and iterative refinement. Educational requirements in different discipline areas progressively shaped the technical and operational model of the online project. For example, “the questions [the teacher] is coming up with are extremely wordy & this does not fit [the current software design]. It does lay the seeds for later modifications to the fundamental model”.

_Reconceptualisations_ were more fundamental and often abrupt shifts in my understanding, strongly correlated with personal _excitement_. This was illustrated clearly in the CAL phase when my thinking switched overnight from building individual tutorial modules to creating a generic authoring environment. “It dawned on me quite suddenly that I had something significant and was referring to ‘authoring tools’ and the term ‘TutorialTools’ emerged” (Feb 1993). This was not just a refinement of educational or technical strategy, but a paradigm shift in my conception of how teachers connected to the technology and what my role would be in facilitating that. The OCCA phase exhibited an almost continuous sequence of pedagogical _reconceptualisations_, as the possibilities opened up were exploited during a period of highly effective collaboration with academic staff (Jan–May 2000). For example, the idea of a students’ ‘learning portfolio’ suddenly opened up a revised notion of student ‘work’ and consequently how students and teachers could engage with the learning process. _Reconceptualisation_ of workplace roles was also a surprisingly consistent theme. I noted, for example, that “my role in OCCA is going through a MAJOR realignment as I pass off my knowledge to others” and also that the role of the tutor in the OCCA system was now central and had been “extended to require a review of student work each week, annotation of student work and giving feedback to course developers”.

The remaining dimensions of the ‘Reflective practice’ category concern _writing_ and _presenting_ through which the outcomes of _investigation_, _re-thinking_ and _reflection_ were articulated. _Writing_ was defined as the writing of abstracts, academic papers, reports or “position statements” for local management. Although _writing_ was undertaken in order to inform and influence local _management_, there was a strong association with _external academics_. _Writing_ helped articulate understanding, while establishing a formal record or planting seeds for further work. _Presentations_ were another form of articulation made at seminars, conferences and other demonstrations to faculties, the university, other institutions, professional groups and/or external companies.
12.3.3 CFL development activities

Chapter 5 reviewed various models of design and CFL development in the literature. This analysis provides an alternative view of the process from the perspective of the developer within a real life situation. The ‘CFL development’ category of the Classification Framework identifies dimensions of planning, instructional design (ID), programming, implementation, evaluation and documentation emerging from the grounded analysis of empirical evidence (Figure 12.6).

![Figure 12.6 Dimensions associated with CFL development, in terms of ‘EventDays’ across all phases](image)

The plan dimension refers to the preparation of workplace strategies, for example, to propose “development tasks of the future” or prepare a “strategy for implementation” of a project. Planning was correlated with writing, promotion, negotiation and university management and was an attempt to purposefully locate a project within the wider organisation setting. This was particularly apparent at the commencement of the online project in the formulation of a detailed “strategy for implementation of the Tutorial Engines project”, by bringing together a project overview and outlining the impact on the curriculum, roles and responsibilities. Similar planning was undertaken within the LE and OCCA phases.

Instructional Design (ID) emerged in connection with the formal process of the educational design, typically involving the definition of instructional goals, objectives, strategies and assessment items. Programming, implementation and evaluation were treated as a separate dimensions. During the CAL phase, I was formally employed as an ‘instructional designer’ and attempted to apply this approach to the development of tutorial materials, although this was “not received enthusiastically” by the academic community. In time, my approach to educational design became less formal and harder to identify. ID is correlated with my work on project teams, but in later projects educational design was seen as the responsibility of teachers.

Programming was clearly the dominant activity across all phases of development, reflecting the significance of the production goal of this study – to produce a generic online software learning system. Programming was
strongly correlated with overwork and stress. It is significant also that programming was negatively correlated with almost every other dimension (Table 12.3, p. 197). That is, programming was an all-absorbing task, carried out at the expense of other activities, often for long hours and over extended periods. It was also at the leading edge of what was possible with the given technology. Over the different phases, I pushed to the limit three programming environments: HyperCard, Director and JavaScript, in order to articulate my vision of a generic learning system. While it may be inferred that the developments were driven primarily by technical considerations, it is worth noting that educational strategy or idea emerging in discussion with academics, might have then taken weeks or months to implement.

The implementation dimension represents those periods in which I was directly involved with the delivery of CFL curriculum materials. It is correlated primarily with academic and student contact, personal excitement, overwork, stress and collaboration, and emerges in only two of the six phases. In TutorialTools, I was very much on hand during the running of the first CFL tutorials. These were early days for both students and teachers in the use of technology (Mar 1993). I had a similar involvement during the implementation of OCCA workshops in Physiology, which involved “week by week development, just keeping up with [student] workshops” (Mar 2000). These periods involved close collaboration with academic staff.

In the earlier CAL and TutorialTools phases, I was directly involved in evaluation of students, for example, using “think-aloud” techniques, “audit trials of student activity” and helping with student interviews. There were a number of reasons, however, why this dimension was not more prominent and was absent altogether in later phases:

- curriculum evaluation was usually undertaken by teachers themselves (for example: Grant et al., 1995; Kavnoudias et al., 2000; Kemm, Kavnoudias, Fritze et al., 2000; Kemm, Kavnoudias, Weaver et al., 2000; Kemm, Williams, Kavnoudias & Fritze, 2001; Kemm, Williams, Kavnoudias, Fritze et al., 2001; McNaught et al., 1993; McNaught et al., 1995; McTigue, Tregloan, Fritze, McNaught & Hassett, 1995; McTigue, Tregloan, Fritze et al., 1994; McTigue, Tregloan, Fritze, McNaught, Hassett et al., 1995; McTigue, Tregloan, McNaught, Fritze et al., 1994; McTigue, Tregloan, McNaught, Fritze et al., 1994);
- a formative evaluation process was hidden within other dimensions, such as reflection, reconceptualising and rethinking, and associated with action research; and
- evaluation of the generic online learning system of this study must also consider its uptake and impact within the institution (Fritze et al., 2000, pp. 7-10). That is, the writing of this thesis itself encompasses an evaluation process not visible within the data.

The final dimension within the CFL development category is documentation, which was associated with writing user manuals, product overviews, technical documentation, or other resources for teachers or developers. For example, I produced a full user manual for TutorialTools and a Web site to provide “examples of the current online activities to illustrate the philosophy behind the Learning Engines project”.

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12.3.4 Interaction within the organisation

Dimensions of the ‘organisational’ category described interaction with teachers, colleagues, managers and others, such as consulting, discussing, negotiating, promoting, funding and collaborating (Figure 12.7).

![Figure 12.7 Dimensions associated with organisational activity in terms of ‘EventDays’ across all phases](image)

*Consulting* involved advising academics on the potential use of CFL in their teaching. This was often in the context of investigation of opportunities for funding. There were two major periods of consultancy. Once the TutorialTools software was basically complete, my role changed to providing advice for academics setting up tutorials (Mar 1994). Later, in the LE and OCCA phases, consulting focused on interest by teachers in obtaining innovative curriculum project grants. Given my position in the Central Unit, the University funding program provided an opportunity for me to discuss project funding possibilities with academics from across the University. While not all consultations progressed, some involved the creation of prototype models, or resulted in successful project collaborations. Such consultancy exposed me to a broad cross-section of learning requirements, from which I was in a unique position to factor the requirements for a generic online system.

*Discussions* with managers, colleagues and academics were generally initiated by me, in order to seek information, explore possibilities, or resolve situations. They concerned a wide range of issues, such as discussion with a manager over “current workload and the focus of my work”; with colleagues on technical strategies; or with academics on the state of current projects.

*Negotiations* described the resolution of issues to reach a satisfactory agreement. For example, I negotiated a “firm contract for me to complete the … software by mid January”. The assignment of intellectual property rights also required negotiations at different stages of the online development. Negotiations were sometimes a cause for concern, but could also have pleasing outcomes. A correlation with colleagues, planning and collaboration was revealed.
Promotion emerged as deliberate action to promote an idea or approach within the institution, for example, my (futile) attempt to "interest staff with [the instructional design] approach". To facilitate the likelihood of uptake of products or collaborations, I purposefully arranged workshops, demonstrations, Websites and direct discussions to keep potential users "informed of what we are doing" or to "get our foot in the door early". These promotional activities were aimed at managers, academics and colleagues, as well as external companies and academics from other institutions (Jun 2000). Promotion sowed important seeds for collaboration and uptake with both colleagues and potential academic users.

Collaborations with colleagues, academics and external academics were one outcome of promotional activities. Some collaborations were formally arranged, such as a “CUTSD Grant Application with Wollongong”. Others involved external companies, such as an agreement with MelbourneIT to explore the "potential link between LE and CMILE" (May–June 1997). I also engaged closely with colleagues and teachers in informal collaborations, for example, through “many discussions, lunches”. A particularly significant example of collaboration with academic staff occurred within the Physiology ‘Group Project’ (Jan–Aug 2000).

12.3.5 Involvement with different communities

The final category of the Classification Framework describes ‘Community’ groups associated with the CFL development (Figure 12.8).

![Figure 12.8](image.png)

*Figure 12.8 Dimensions associated with community contact in terms of ‘EventDays’ across all phases*

The colleagues dimension referred to my direct involvement with non-teacher peers in the same work unit. Such connections only occurred after I moved from a single department to the Central Unit after 1994. From this point, I had opportunities for interaction with PhD students, programmers and academic staff directly involved with educational technology. These interactions with colleagues were associated with *rethinking, investigation, collaboration, negotiation and discussion*. Colleagues provided an invaluable sounding board for ideas, although at times, I recorded a concern over unresolved technical issues, roles or intellectual property issues.
Interactions with academic teaching staff are consistent across all phases and form the basis of my work. Academic contact was strongly associated with my consultation activity. Involvement with formal project teams occurred in some projects in connection with Instructional Design activities. In the later phases, notions of a systematic ID approach and clearly structured project teams were replaced by more fluid collaborations between academic staff and colleagues.

Contact with students appeared minor but formed an important reference point. For example, I noted that it was of “great benefit to see students in action”. This contact occurred during evaluation trials and initial implementation of TutorialTools (Mar 1993), and again during OCCA, when I had the opportunity to sit in on student workshops in which the online system was in use (Mar 2000).

Contact with university management occurred at both local and institutional levels. Interaction with local management involved discussion of roles, responsibilities, project related issues and formal reflection in staff appraisal sessions. Although relatively few in number, these sessions seemed to provide an important mechanism for me to discuss ideas and receive feedback and support. Interactions at the level of University management included discussions with key individuals and work on committees. Although relatively few in number, I was able to present the development to strategic individuals, such as the DVC (IT), University committees and working groups. This also appeared to be an important mechanism for promoting the development, establishing contacts and obtaining feedback from a strategic level.

University unit staff worked in other educational support areas. These contacts provided a source of advice and ideas, as well as opportunities for funding, presentations and promotion. A number of collaborations were evident, particularly in evaluation or the writing of research papers.

Contacts established with external academics appeared consistently across all phases and are worthy of note. This was clearly something that pleased and interested me. Such contacts were often made during conference presentations. A number of collaborations were explored and licence agreements were arranged for academics in a number of institutions to use both TutorialTools and OCCA. Contact was also maintained with individuals from companies such as MelbourneIT, WBT Systems (TopClass), Apple Computers, and programming contractors.

In summary, dimensions of the workplace experience were examined against the Classification Framework of personal feelings, reflective practice, CFL development, organisational activities and community involvement (Section 12.2.1). The dimensions and their relationships were described and explained through an integrative analysis that related evidence from the statistical correlations, narrative history and raw data. In the following section, this description will be drawn together in a Developer-centred Innovation Model of workplace experience.

12.4 An emerging model of CFL systems innovation

The descriptive categorisation of the workplace experience of the previous section is further developed here as a conceptual model of relationships that might better predict and explain the innovation process (Strauss & Corbin,
1998, p. 15). While the model relates only to the particular case studies examined, the conceptual relationships it embodies can be usefully tested against other data and contexts.

12.4.1 Clarifying the innovation context

In order to clarify the context of the innovation model, five general characteristics of the case studies have been identified, with an emphasis on the generic online development:

- a particular tertiary/academic environment and timeframe;
- generic, university-wide educational solutions;
- an innovation process driven by the individual; and
- leading edge application of ICT; and
- the innovation phase of a longer term process of institutional change.

These contextual features highlight the particular nature of the setting and will assist in judging transferability of the model to other contexts. They are outlined individually below.

A particular tertiary/academic environment and timeframe

The case studies are set within a University environment that could be generally described as ‘collegial’, allowing staff relative “freedom to pursue university and individual goals unaffected by external control” (Section 6.2). A major factor in this freedom, from the viewpoint of innovation in teaching at least, was the University policy between 1997 and 2001 provide competitive innovative teaching grants to teachers (Section 1.4). This centralised program made possible my access to the multiple curriculum projects that underpinned the generic system development. By 2002, the focus of grants had shifted to university-wide infrastructure projects with individual faculties taking more responsibility for their own funding and teaching priorities. In applying the innovation model in other contexts, it would be necessary to carefully consider the particular climate for innovation fostered by the institutional setting.

Generic, university-wide educational solutions

The first goal of this research was to develop a generic online learning system, relevant to all disciplines. Production of individual curriculum projects was a key element of this, but within these, the innovation process had to remain open to the broader consequences of design decisions. That is, the generic and multi-disciplinary nature of the development had to be reflected in the innovation methodology. The innovation model therefore must support mechanisms that foster multi-disciplinary solutions and extend the boundaries of any single teaching setting.

One approach to designing a generically useful CFL system is to devise a complete set of high-level educational functions meeting a wide range of users’ needs. This is the approach taken by commercial Learning Management Systems, such as WebCT. Another approach is to develop only a minimum framework of low-level operations, on top of which customised functions can be constructed as required. The evidence in this study reveals that, between 1996 and 2000, the generic development shifted from the first approach to the second.
An innovation process driven by the individual

The evidence in this study also shows an innovation process centred very much on the individual researcher/developer. This provided certain advantages, for example, a means to push leading edge technology and design ideas to the limit with rapidly evolving prototype designs, where a larger team would have more difficulty coordinating effort. Having a single individual undertaking multiple aspects of the development minimised the need for articulation of still fluid designs, which remained internal to the designer. Nonetheless consultation, collaboration, negotiation and discussion played a key role in the innovation process. A particular balance of communication and control focused on the developer is a key characteristic of the innovation model.

Leading edge application of ICT

The development of CFL systems in this study has exploited contemporary technologies to their limit. This was a critical characteristic of the development that shaped the nature of both the workplace experience and production outcomes. Use of technologies in a more ‘predictable’ manner would have led to entirely different processes, players and experiences, with different consequences for the University. I am not suggesting that there is a ‘correct’ approach, only that the empirical evidence in this study clearly reveals one possible process characterised by high risk, repeated ‘failure’, iterative adjustment and novel solutions. This approach did extract a cost in terms of individual workload associated with problematic technology and the demands of teaching timetables. The final outcome, however, is arguably a unique educational and institutional approach in line with the original mission of this study (Section 2.2).

The innovation phase of a longer term process of institutional change

Finally, the evidence suggests that the study examined primarily the innovation phase of a longer-term online development. Wider uptake of the system by some departments and the Central Unit was indicated, but as a generic model, there is clearly scope for broader institutional impact. Based on this evidence, the model focuses on the process of innovation from the perspective of individual. While strategic engagement with the institution was visible within the developments, longer-term institutional mechanisms for diffusion of innovations are beyond the current scope of the model.

12.4.2 A Developer-centred Innovation Model

In this section, the descriptive representations from the grounded analysis are drawn into a prototypical model to further explain and relate workplace phenomena. This model provides a starting point from which other experiences of innovation can be examined, but with acknowledgement of the specific context in which it has been developed. The intention of this ‘Developer-centred Innovation Model’ is to provide a concise conceptual framework of key phenomena emerging from empirical evidence.

The model primarily draws from the deconstruction of the workplace experience in Section 12.3. This was presented as a descriptive interpretation and statistical analysis of dimensions, corroborated and illustrated by evidence from the narrative history. There are three main elements to the Developer-centred Innovation Model, which is summarised in Figure 12.9:

- representation of the community in which the developer interacts;
- interactions of the developer with others; and
The developer-centric structure of the model is apparent in Figure 12.9. The main community players interacting with the developer are modelled on the ‘community’ category of the Classification Framework (Table 12.1) and are described in detail below. Arrows indicate primary interactions suggested by positive correlation between dimensions (Table 12.2) and direction of information flow. Core relationships with the developer are in bold, for example, potential local adopters, colleagues, technology, early adopters and the ICT system itself. This is not to say, however, that other connections were not important. The developer’s personal perception of the workplace situation is indicated by icons representing excitement or interest, concern, and overwork or stress.

Figure 12.9 The Developer-centred Innovation Model for CFL systems development

This representation of a particular experience of ‘innovative practice’ is not put forward as the only way in which innovation in ICT might be approached. In fact it is concluded that this model describes a high risk, resource-intensive, individually focused and contextually dependent approach. Its qualities, however, do resonate with the research-orientated culture of universities and have been consistently supported within the institution over a period of nine years examined in the study. I contend also that it was through this systematic investigative process that a unique learning product has been formed.
Key elements of the Developer-centred Innovation Model are discussed below. References to the underlying dimensions from the Classification Framework of Section 12.2.1 are indicated in italics.

**Management**

Although an analysis of broader institutional factors was beyond the scope of this study, funding and management policies at University and Central Unit levels greatly influenced the nature and outcomes of the innovation process across the entire study. Dashed lines in Figure 12.9 indicate the existence of this connection between University and Central Unit management and other players. Thus the context of the local innovation process was determined to a large extent by institutional policies, outside the developer’s sphere of control. Direct discussions between the developer and key managers, however, were consistent over the full period and may well have been strategic to the innovation process. In the next chapter, I will shift the perspective of this model from the developer to those outside the innovation process, including managers.

**Innovator developer**

Figure 12.9 reflects the close control I maintained over the generic development, emphasised by the centralised position of the developer and the major ICT system programming work occurring across all phases. This was an iterative activity accompanied by adjustment in *thinking* and major *reconceptualisation* of approaches. It was on the one hand problematic and stressful, on the other it was exciting to discover solutions and new ways of seeing. The ongoing exploration of new technologies was evident as purposeful *investigation* of new possibilities and *rethinking* of approaches.

It is worth comparing this model, which is based on empirical evidence of actual workplace experience, with the action research prototyping method discussed in Section 8.3. The software production method was described in broad terms as iterative prototyping, using a fluid interpretation of approach, pragmatic levels of formalisation and capitalising on multiple curriculum projects. The grounded model, however, portrays a more micro-level representation of the actual players and their interactions. It suggests that, in addition to the expected cyclic processes of development and reflection by the main collaborators, there are other important but often unrecognised roles. Connections with potential local adopters, an external reference group, colleagues and management assisted the developer with the articulation of ideas, aligning the initiative within the institutional setting and planting seeds for wider uptake.

There are eight groups with whom the developer appeared to interact to varying degrees and for different purposes.

**Early adopter/innovators**

The small group of early adopter/innovators were the key academics with whom I *collaborated* on key curriculum projects (for example: Fritze *et al.*, 2000; Grant *et al.*, 1995; McTigue, Tregloan, Fritze *et al.*, 1994). This group *implemented* and *evaluated* courses through which I was able develop generic CFL approaches and maintain contact with *students*. They represent a small minority of the academics with whom I *consulted* with over the years. Although not fully investigated in this study, such early adopter/innovators would appear to have particular perspectives on education that make them of potential value to the institution. The degree of
collaboration varied over time and with different individuals; however, it was only in the last phase that I felt a genuine collaborative practice had been achieved (Fritze, Kavnoudias et al., 2001b; Kavnoudias et al., 2000).

Specialist colleagues
The second key group clearly interacting with the developer included colleagues working in the Central Unit (see for example: Ip & Fritze, 1998b; Ji et al., 1998; Kennedy & Fritze, 1998). Their parallel interests and specialist understandings were critical in fostering an environment in which ideas could be nurtured through endless discussions and debate. It appears, however, that attempts to negotiate formal agreements and collaborations did not lead to anticipated benefits. This appeared to be related to the specialised interests of each individual and the likelihood that they operated within similar developer-centric roles. That is, this model may well break down when the control of innovation is shared.

Potential local adopters
The third group is somewhat unexpected. In the generic online development (1996–2000), I provided consultancy to a wide range of academic staff from different disciplines, who approached me for advice regarding possible project funding possibilities. I often developed prototype demonstrations to promote possible approaches, which was an important step in the development process. My contact with local adopters provided exposure to real content material, forcing me to reflect on and rethink my conceptual models. For example, it was a sobering experience to find out that an Arts-based discipline required students to submit large quantities of text, unlike the Science-based disciplines I was used to. This led to a fundamental re-conception of how I perceived both student learning and the possibilities of technology.

Although these consultations and prototyping experiments are not formally acknowledged, they were of strategic importance in defining the generic character of the online development. I do not believe that a genuinely generic product would have resulted without exposure to the views of learning coming from many disciplines and individual teachers. It should also be emphasised again, that University funding initiatives were the principal reason for the interest by potential local adopters and key collaborators. Without this organisational strategy in place, the nature and extend of involvement of academic staff in teaching innovation would have been quite different.

Target users
I generally had little direct contact with the student end users of the CFL systems. Teachers had responsibility for implementation and evaluation of their subjects and it would not have been appropriate for the developer to take this role. I did, however, come into contact with students at certain stages. For example, in the OCCA phase, I worked closely with teachers on a week-by-week basis and the time in the computer laboratory provided me with valuable views of the learning and teaching process (Fritze, Kavnoudias et al., 2001b).

External reference group
The external academics I met at conferences or when visiting other institutions formed an external reference group for the development. This was somewhat unexpected, but consistent throughout the study. This was a very diverse group of individuals who I found were interested and willing to discuss and exchange ideas. Writing
academic papers about the development and presenting at conferences provided an important means of reflecting on the development and articulating ideas to a critical audience. Even in a large University, there are only limited numbers of individuals interested in CFL at a certain level, as indicated by the small number of early adopter/innovators. Conferences provided space and time away from regular pressures that stimulated discussion and reflection, as well as possibilities of collaborations.

External markets

External companies and the possibility of commercial uptake of the development surfaced at different points. Although no commercial agreements were reached, the exercise of promoting ideas and the possibilities for collaboration contributed to the development process.

Local specialists

At different stages I associated with individuals in other educational units in faculties and department for the purposes of evaluating particular curriculum projects, discussing possible projects or presenting staff development of courses.

The Developer-centred Innovation Model attempts also to capture personal reactions by the developer to the experience. It has been suggested that exploitation of the leading edge potential of technology may lead to transformative outcomes in education, but may also fail spectacularly. This tension was seen from the perspective of the developer as workload and stress, associated with technical programming, concerns raised by negotiations over roles, management strategies and intellectual property issues. To the developer, these negative effects appeared to be in balance with intellectual interest and excitement. It would appear that this model suggests a range of background skills and attitudes required by the Central Unit innovative developer:

- a breadth of skills that enable technical and educational design to align;
- a capacity to take on high work loads in order to force a solution when necessary;
- a motivation from intellectual challenge to balance stress associated with risk; and
- an ability to recognise and accommodate a wide range of perspectives.

The developer in this model provides a link between new technologies and the requirements and visions of teachers. This role is portrayed as a continuous engagement with stakeholders at a number of levels that appeared to cut across traditional workplace roles and tasks. The model represents an alternative to more systematic design approaches employing strengthened project management and up-front needs analyses that would increase predictability of developments, but lower the capacity for iterative responsiveness to emerging understandings and the limitations of leading edge technologies.

To utilise the Developer-centred Innovation Model, an institution needs to understand the contextual factors that foster innovation and the motivations and workplace practices of individuals. An organisational perspective on this innovation model will be examined in the next chapter.
12.5 Summary

This chapter builds from the narrative histories of two CFL development case studies to further develop an understanding of the workplace experience (Goal 2 of this study). A Classification Framework for categorising workplace phenomena was developed from grounded analysis of contemporary documents, communications, software artefacts and personal journals. The emerging dimensions associated with my personal feelings, reflective practice, CFL development activities, organisational interactions and community contacts formed the basis for the analysis in the chapter.

A quantitative analysis was used to explore variation between the dimensions across the phases of development. Relationships between dimensions suggested by a correlation analysis then provided a framework to further deconstruct workplace experience. In this integrative analysis the quantitative findings were drawn together into a comprehensive descriptive account of the workplace experience, corroborated and illustrated by evidence from the narrative history.

This account indicated that the CFL innovation experience was dominated by programming activity associated with periods of extended work and stress, often associated with curriculum deadlines and technology failures. These negative feelings appeared to be balanced by personal interest and excitement associated with exploration and discovery. The pattern of workplace practice demonstrated a consistency over the different phases and between the two case studies that they encompass. The key activity of the developer was marked by purposeful action to investigate new approaches, consult with academics and seek funding for projects, to promote and reflect on the development, and to generally locate the project within the community. The evidence revealed that strategic interactions occurred with a range of individuals and groups, most critically a small number of academic early adopters/innovators. Important discussions took place with workplace colleagues. Less obviously, contact with a ‘reference group’ of academics from other institutions enabled ideas to be tested and exchanged within a neutral setting.

This descriptive deconstruction of the workplace experience was further developed into a Developer-centred Innovation Model. This reflected the particular university environment and timeframe in which the empirical evidence was collected. The model emphasised the central role of the developer and connections to eight particular groups including University management at a number of levels, potential local adopters, early adopter/innovators, an external reference group, students, external markets and specialist colleagues. It represents an alternative to more systematic design approaches that would increase predictability of developments, but lower responsiveness to changing understandings and limit the transformative potential of leading edge technology.

In the next chapter, this view will be turned inside out, to provide a view of innovation from the perspective of those outside the process, in order to inform organisational understanding and decision-making.
CHAPTER 13. An organisational model for Collaborative Developmental Research

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13.1 Introduction
The third goal of the study was to generate an organisational model to guide further development of innovative CFL (Computer-Facilitated Learning) systems (Section 2.3.3). I have presented this as a generalised model of ‘Collaborative Developmental Research’ (CDR), which is a research and development process potentially relevant to universities transforming learning and teaching through the use of ICT. While a full investigation of broader organisational factors remained beyond the scope of this study, the emerging picture of a personal workplace experience can provide insights to inform organisational strategies and understanding. This analysis is undertaken as a Mixed-Methods inquiry and draws on both grounded analysis and action research methods (Section 7.6).

In the first section of the chapter, the CDR process is related to other CFL development approaches and described in terms of its organisational structure, contributors, stages, potential difficulties and facilitating conditions. In this analysis, the developer-centred experience of innovation in Chapters 11 and 12 is re-examined.
to see what it says about the organisation and how others might see it. Acknowledging the limited organisational data on which it is based, the CDR model is put forward to foster deeper understanding and strategic use of collaborative innovation in the organisation context.

In the second section, the ‘Group Project’ curriculum development in Physiology (Section 10.2) is examined as a collaborative action research case study, which served to both inform and exemplify the CDR model. This provides a specific local example of how the complimentary goals of teachers innovating in their own teaching and developers enhancing a generic CFL system can be productively harnessed.

Methods of analysis applied in the development of the CDR organisational model are outlined in Section 8.5.

### 13.2 A model of Collaborative Developmental Research

The detailed picture of a workplace innovation experience in the Chapters 11 and 12 has primarily focused on my perspective as developer, due to the nature of data collected and my central role. Given this empirical evidence and bearing in mind the limited organisational data on which it is based, I have attempted here to examine what this says about the rest of the organisation. That is, how the process of collaborative innovation is located within the institutional context and how it might be usefully viewed by those outside the process. The analysis draws on evidence emerging from (Section 8.5.1):

- deconstruction of the workplace experience based on grounded analysis (Section 12.3);
- the Developer-centred Innovator Model of CFL systems development (Section 12.4);
- the narrative history of workplace experience between 1991 and 2000 (Chapter 11);
- alternative perspectives on the workplace experience (Section 11.4); and
- the ‘Group Project’ collaborative action research case study (Section 13.3).

The CDR model was formed from a re-interpretation of this evidence through an ‘organisational lens’ as outlined in Section 8.5.2. In particular, it builds on the Developer-centred Innovator Model in Figure 12.9 (p. 209). There are six components to the model:

- a definition of CDR;
- its relationship to other possible institutional approaches to development;
- contributors to the process;
- the process of CDR;
- difficulties experienced; and
- conditions that facilitate effective CDR.

While acknowledging the limited organisational data and contextualised nature of the evidence, the model is presented as a generalised representation, in a language aimed at stakeholders in the organisation. In particular, little evidence in available on the interactions between teachers and other faculty or university roles. The model is illustrated by cross-reference to illustrative examples in the narrative history (Chapter 11) and other evidence.
13.2.1 A definition of CDR

‘Collaborative Developmental Research’ is defined as a collaborative approach to the development of innovative centralised CFL systems in a research-based academic institution. It is a form of research activity that seeks to extend technical, educational and institutional horizons with innovative approaches to learning and teaching, fostered by the leading edge application of ICT. As a partially exploratory activity, it is characterised by evolving aims and understanding, and unpredictability in outcomes.

The developmental aspect of CDR emphasises the dual purposes of:
- developing creative approaches to particular local curriculum problems; and
- establishing generalised understanding and systems to facilitate wider practice (Section 2.3).

This brings to centre stage the need to bridge different perspectives and goals. It contrasts with top-down approaches to systems development that remain at arm’s-length to local requirements, and traditional academic ‘cottage industry’, which may lead to disconnected local solutions (Section 6.4.5).

The third tenet of CDR is collaboration between teachers and central developers, who simultaneously address local curriculum teaching requirements and institutional solutions. This does not mean that participants in CDR will fully agree on, or even understand, each others’ requirements and perspectives, only that there is sufficient overlap in interests and pragmatic negotiation to derive mutual benefit. For example, teachers would focus on local course requirements and deadlines, while the developer would be conscious of generic use and longer-term implementation across the institution.

CDR is well suited to action research prototyping approaches, which support iterative development, reflective practice and implementation via evolving working models (Section 7.4.2). Working prototypes have proved an effective vehicle for negotiating requirements and functionality in a ‘language’ understood by all participants; they can reveal new insights on designs and can respond rapidly to changing understandings (Table 9.2, p. 131; Sections 11.2 and 11.3).

The following sections expand the model of CDR in terms of its role, contributors, characteristic process, potential difficulties and facilitating conditions. Organisational factors are raised as suggested actions.

13.2.2 The relationship of CDR to other approaches

CDR, of course, is only one of many possible approaches to the development of CLF initiatives within universities. Table 13.1 (see p. 217) suggests some of these, loosely organised from top-down to bottom-up. This breakdown serves to highlight the essential characteristics of CDR from an organisational perspective.

From a top-down perspective, university committees or units may commission expert working groups to investigate and recommend strategies, for example, for the adoption of a learning management system. At another level, project teams within central educational units or faculties produce learning materials or tools using systematic production processes. Depending on the methods used, such processes will result in the early
specification of requirements and solutions, with development then undertaken at arm’s length from the teaching and learning environment.

Table 13.1  Different levels of approach to university ICT development within an organisation

<table>
<thead>
<tr>
<th>Approach to development</th>
<th>Description</th>
<th>Organisation actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top-down</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Working group</td>
<td>Purposeful analysis of a centrally identified strategic issue, carried out by assigned ‘experts’.</td>
<td>• Identify areas for investigation. • Make decisions based on recommendations.</td>
</tr>
<tr>
<td>Project team development</td>
<td>Formal project production based on clearly defined specifications, team responsibilities, outcomes and methods.</td>
<td>• Establish formal processes and resources. • Evaluate outcomes.</td>
</tr>
<tr>
<td>CDR</td>
<td>Exploration of innovative ideas by individuals who combine curriculum and organisational interests.</td>
<td>• Foster opportunities for innovation. • Monitor and provide guidance. • Institutionalise outcomes.</td>
</tr>
<tr>
<td>Academic research study</td>
<td>Exploration of innovative ideas by individuals driven by research or teaching interests.</td>
<td>• Diffuse knowledge gained, • Incorporate into institutional quality assurance.</td>
</tr>
<tr>
<td>Bottom-up</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mainstream teaching development</td>
<td>Development of teaching materials by an individual teacher using established approaches.</td>
<td>• Provide effective frameworks for academic support. • Facilitate reuse of resources.</td>
</tr>
</tbody>
</table>

From a bottom-up perspective, academic staff will develop their own teaching materials using traditional approaches, or may actively undertake research into particular aspects of their own teaching. These traditionally independent academic practices are likely to be at least one step removed from centralised efforts to facilitate sharing of teaching approaches or resources. Such independent academic research may eventually be incorporated into the organisational perspective, but its purpose is primarily to improve personal teaching practice and/or engage with specialised research communities.

CDR pursues innovative solutions by straddling top-down and bottom-up approaches. It harnesses the drive and understanding of individual teachers introducing new approaches to their teaching, and developers focused on producing innovative centralised CFL systems for the organisation (Section 12.4.1). These multiple perspectives on creativity are the key to organisational innovation. Like other forms of research, CDR is not a process that can simply be ‘switched on’ to solve an identified institutional problem. The nature of the problem may not even be recognised until alternative ways of looking at an existing situation are presented. The organisation, however, can maximise opportunities from such ‘blue sky’ research through strategic policies, for example, targeted funding programs or support for networking opportunities (Section 11.4.3).

CDR is driven as much by the insights and efforts of key individuals, as by purposeful organisational planning. In all probability, innovation will reflect a serendipitous alignment of opportunities and individuals, as indicated by the small number of genuinely productive collaborations arising in the study (Section 12.4.2).

13.2.3 Contributors to the CDR process

The generalised structure for CDR in Figure 13.2 is a simplified interpretation of innovation experience in this study. It should be interpreted quite loosely according to its application within particular contexts (Sections 12.3.4; 12.3.5; Figure 12.9, p. 209; Section 13.3.1).
The CDR initiative itself focuses on a key collaboration between a ‘Central Innovator’, reflecting the interests of a Central Unit, and individual teachers within faculties – the ‘Early Adopter-Innovators’. Organisational stakeholders in the process include ‘University Management’, ‘Faculty Management’ and ‘Central Unit Management’. Important secondary interactions also occur between Innovators and workplace ‘Colleagues’, other ‘Mainstream Teachers’, and ‘External Networks’ of individuals from other institutions or companies. Potential roles and contributions of this community are outlined in Table 13.2 (Sections 11.4.3, 12.4.2).

**Table 13.2  Role and contribution of organisational participants in the CDR process**

<table>
<thead>
<tr>
<th>Participant</th>
<th>Description</th>
<th>Contribution to CDR process</th>
</tr>
</thead>
</table>
| University Management | University committee structures, key individuals in management roles. | • Set up funding to encourage aligned innovation.  
• Provide strategic leadership and direction.  
• Monitor and guide process.  
• Identify opportunities and problems. |
| Faculty Management | Line management in faculty. | • Provide resources.  
• Faculty strategic policy. |
| Central Unit Management | Line management in educational technology unit. | • Provide necessary resources, professional development opportunities and authority.  
• Provide critical feedback and direction.  
• Mediate in negotiations and collaborations.  
• Monitor and guide changing roles of staff. |
| Colleagues in Central Unit | Other experts in Central Unit with related roles. | • Provide sounding board for ideas.  
• Provide specialist advice and support.  
• Collaborate on projects. |
| Innovator within Central Unit | Developer driving prototype CFL System. | • Instigate and promote conceptual design for innovative CFL Systems.  
• Seek collaborations.  
• Develop prototype solutions. |
| Early Adopter-Innovators in faculties | Teachers prepared to experiment with new teaching approaches. | • Instigate ideas and initiatives for new approaches to teaching.  
• Organise project funding.  
• Develop curriculum approach and materials.  
• Implement teaching.  
• Maintain backup teaching strategy. |
| Mainstream Teaching Staff | Teachers who may adopt new approaches when appropriate. | • Discuss ideas and workplace requirements with developers.  
• Provide feedback on initiatives. |
| External Networks | Individuals from other institutions, companies and professional groups. | • Provide forum for discussion with interested experts.  
• Provide a neutral sounding board for ideas.  
• Provide source of potential collaborations. |
University and Faculty Management are able to foster collaborations between teachers and Central Innovators through policies, such as targeted project funding programs (Sep 1991, Oct 1991, Oct 1997, Jan 1999). Opportunities may also exist at national level (Jan 1999, Mar 1999). Even if no formal collaborations eventuate, these programs will still provide an important catalyst for the exchange of ideas (Section 12.3.4). University Management can also provide guidance and strategic insight to innovators by involving them on committees or working groups (Section 12.3.5, Jan 1999). While Faculty and University Management clearly influence the teachers’ environment, a lack of data in this study limits their representation within the model.

Management of the Central Unit influence the workplace environment in which cross-institutional CDR initiatives are likely to be fostered (Section 11.4.3, Apr 1997). The extended investigative activity associated with innovative development requires significant personal space, resources and freedom for the innovator to pursue ideas, engage in formative discussions and test technologies (Apr 1996, Section 12.3.2). General direction from the Unit and University’s strategic objectives may be maintained through regular written reports, staff meetings (Aug 1998), seminars and staff appraisal processes (Section 12.3.2). Unit Management may need to guide and support initiatives through critical points by rearranging staff roles (Aug 1999, Section 11.3.5); finding additional resources, such as programmers (Jan 1997, Sep 1998); and negotiating agreements (Sep 1996, Apr 1997, Aug 1998).

Central Unit Colleagues provide an important sounding board for ideas, a source of expert advice and may collaborate on projects (Sep 1996, Jan 1997, Apr 1997, Sections 11.4.2, 12.3.5). Other projects may provide a source of shared ideas and resources where an open collegial culture exists (July 1998, Oct 1998, Aug 2000), although formally aligning projects may prove difficult (Aug 1998, Jan 1999, May 1999, Section 11.4.2). As the initiative moves beyond the prototyping phase, involvement of other Central Unit staff, such as project managers, programmers and educational consultants, may be required (Aug 1999).

The Central Innovator is clearly fundamental to the CDR process (Section 12.4.2). Their central position, ‘R & D’ orientation and multiple skills sensitise them to opportunities for initiatives that link institutional, faculty and technological requirements. By maintaining a strong influence on alliances, project direction and programming, conceptual and technical designs can respond efficiently to evolving understanding and circumstances (Sections 0, 11.3.3, 11.3.4, 12.4.2). By avoiding the need for external representation of the design and tasks, the Innovator can make subtle adjustments in approach that would otherwise require more extensive coordination. While CFL innovation is often consider the domain of the ‘lone innovator’ (Section 12.4.1), the evidence indicates that CDR is certainly not carried out in isolation. The Central Innovator maintains strategic ‘horizontal’ connections with other individuals, through which ideas, collaborations and expertise are brought in to the development. That is, the nature of innovative research requires formation of eclectic project groups that cut cross formal organisational structures. The generic nature of a CFL initiative is also likely to require multiple collaborations with Early Adopters, representing different discipline and learning needs.

The other key member of the CDR initiative is the Early Adopter-Innovator (Sections 11.4.1, 12.4.2). These are teachers who, as independent researchers into their own teaching, can be key drivers for generic initiatives (Nov 1998, Jan 2000, Section 11.4.1). When the interests of Early Adopters and a Central Innovator resonate, extended interchange of ideas and/or project collaborations may result; however, the evidence suggests that the
productive CDR collaborations are relatively rare (Section 12.4.2). Although there is no direct evidence, it is probable that Early Adopters will also maintain a horizontal network of connections within and outside the University.

*Mainstream Teaching Staff* are potential users of the CFL System initiative; their requirements therefore must critically inform its development (Section 12.4.2). It is important to recognise that these mainstream requirements may contrast with those of Innovators and Early Adopters, and may ultimately determine whether a generic innovation is successful (Section 6.4.5). Opportunities for discussions between Mainstream Teachers and the Central Innovator can be fostered through professional development or funding programs.

Finally, CDR Innovators draw on an *External Network* of individuals from other institutions or companies as a sounding board for ideas and a possible source of collaboration (Apr 1997, Jan 1999, Section 12.4.2). It appears necessary for innovators to look outside the institution for individuals with similar specialised interests. In addition, such discourse can occur without formal institutional responsibilities affecting the free exchange of ideas (Jun 2000).

### 13.2.4 The process of CDR

A generalised structure for the CDR process based on evidence of the study is shown in Figure 13.3. The innovative activity involving the Central Innovator and Early Adopters progresses through six stages, from the initial investigation of ideas to packaging for wider institutional use. At different points the organisational management provide support and guidance, while a community of potential adopters, colleagues and external network provides feedback, opportunities for collaboration and a sounding board for ideas. The six stages, their contributors and suggested organisational actions are indicated in Table 13.3.

![Figure 13.3 Generalised model of mains stages of the CDR process](image-url)

**Figure 13.3** Generalised model of mains stages of the CDR process
### Table 13.3 Main stages of the CDR process

<table>
<thead>
<tr>
<th>Stage</th>
<th>Activity</th>
<th>Main contributors</th>
<th>Suggested actions</th>
</tr>
</thead>
</table>
| Initial investigative activity | Exploration of ideas, technologies and collaboration. | Innovator, potential local adopters, managers, reference group, colleagues. | • Provide personal space and resources for investigation.  
• Ensure organisational objectives guide directions, e.g. brainstorming sessions involving all stakeholders. |
| Formalisation of initiative | Curriculum project agreements, authority of management. | Innovator, early adopters, managers. | • Formally funded strategic projects.  
• Incorporation into individual workplace objectives. |
| Prototype developments | Development and implementation of curriculum projects using prototype system. | Innovator, early adopters, colleagues. | • Recognise investigative nature of task, workload and pressure.  
• Provide additional resources where appropriate.  
• Ensure fall-back procedures are in place.  
• Offer encouragement. |
| Reflection | Testing, experimenting, presentation and discussion of ideas. | Innovator, early adopters, reference group, colleagues. | • Enable individual space and resources for some flexibility.  
• Facilitate and encourage collaboration, presentations, meetings with visitors. |
| Turning points | Initiative changes emphasis – reaches dead-end, scaled up or terminated. | Innovator, early adopters, managers. | • Monitor progress.  
• Openly discuss and facilitate change of roles, closure.  
• Provide adequate support for next stage. |
| Packaging | Software refinement, documentation, packaging wider adoption. | Colleagues, managers, mainstream teachers. | • Consider bringing in others less ‘involved’ and able to relate to target users.  
• Address sustainability issues. |

CDR initiatives may involve an initial period of wide-ranging *investigative activity*, when ideas are floated, prototypes tested and potential collaborations explored (Sep 1991, Apr-Sep 1996, Section 12.3.2). This appears to be important in setting up an interest network and formulating a conceptual and technical approach. Such activity might be instigated in response to management policy, for example, funding programs.

*Formalisation* of a collaboration can play a key role in consolidating a conceptual approach (Sep 1996, Aug 1998). For example, integration into organisational objectives will establish legitimacy and alignment of a project (Sep 1996, Aug 1998). The preparation of management reports or funding applications will require the articulation of the conceptual design, helping to clarify the initiative and stakeholder responsibilities. While CDR initiatives by their nature will continue to evolve, teachers will at some stage require a commitment to the delivery of course materials.

The evidence in this study indicates that the *prototyping* of software is a time-consuming aspect of CDR (Section 12.3.3). Programming of leading edge developments requires the skills and drive of the Innovator, who must balance complex technical and educational designs, while avoiding technical dead ends (Feb 1999, Section 12.4.1). At the same time, teachers and managers would be wise to prepare contingency plans, should the initiative not be deliverable on time.

The evolutionary nature of the development will require a continuous cycle of testing and *reflection* on the prototype designs, discussion and access to expert advice (Section 12.3.2). It is interesting that throughout this period, the Innovator may actively ‘promote’ the initiative, even to upper management, sowing seeds for further collaboration or adoption (Sep 1996, Section 12.3.4). Management may also organise strategic meetings and

The iterative development cycle is punctuated by occasional critical turning points requiring decisions about a project’s directions or even continuance. These may be associated with curriculum timetable requirements or triggered spontaneously by major reconceptualisations of approach (Section 12.3.2, Sep 1998); technical crises (Mar–May 1998, Feb 1999); emergence of alternative products (Apr 1997); or external events such as organisational restructuring (Jan 1994). At some point, a ‘successful’ innovation initiative will require prototyping activity to conclude and dependence on the key innovators reduced or removed. This point may not be recognised by the Innovator, however (Jan 1994, Aug 1999). At such turning points, management can to play a crucial role in facilitating changing staff roles (Aug 1999), providing additional resources (Jan 1998) and limiting fall-out from restructuring (Jan–Sep 1994, Feb 1999).

In the final stage of the innovation process, some form of packaging will be required to facilitate uptake of the initiative beyond the immediate CDR group – assuming this is warranted. This is sometimes referred to as ‘institutionalisation’ (Section 6.4.5). Tasks at this stage include improving usability of the software, preparation of support materials, professional development and documentation (Sep 1993). The nature of these activities contrasts significantly with the CDR process itself and Innovators may not be best placed to understand the requirements of this stage.

13.2.5 Managing potential difficulties

As a research-orientated developmental approach, CDR is characterised by unpredictability and potential management difficulties. The analysis of workplace experience of CFL development in this study provides some insights that might inform organisational decision-making. Table 13.4 (see p. 223) lists some observed difficulties and suggested management strategies.

CDR initiatives depend on the control individual innovators exert to balance complex designs and evolving understanding. Such dependency, however, brings an associated risk that other factors may be avoided or even actively resisted, for example, organisational needs for documentation (Jan 1994). The evidence suggests that it may be difficult to organise formal alignment of independent research developments between researchers or companies (June 1997, Oct 1997, Aug 1998, Jan 1999, Section 11.4.2). Innovators tend to work within their own eclectic ‘horizontal’ networks, which may conflict with the requirements of formal organisational structures.

Demonstrations of prototype designs will often portray a deceptive picture of the state of development, as they are almost invariably based on incomplete software and limited content material (Feb 1997, Apr 1997, Aug 1998). Innovators will often avoid giving others access to incomplete software versions – they know how work demonstrations to avoid missing parts and ‘bugs’. This situation is expected in the early stages, but in time the software should be more openly available for others to access and test.

Both Innovators and Management are inclined to believe that prototype designs, conceived and tested within a particular innovation setting, will simply transfer to ‘real’ student and workplace environments (Section 6.4.5).
One noted problem is that full-scale implementation within real settings will expose unanticipated technical problems (Apr 2000, Jul 2000). Design problems will also become apparent during the ‘packaging’ stage, when a wider group become involved.

Table 13.4 Potential difficulties associated with the CDR approach and suggested management strategies

<table>
<thead>
<tr>
<th>Difficulty</th>
<th>Effect</th>
<th>Suggested management strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loss of control</td>
<td>Innovator steers project direction away from real needs of organisation or unit; won’t adopt a team approach; or will not relinquish control of software.</td>
<td>• Recognise research nature of activity.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Continuously monitor initiative and be prepared to expand involvement at the appropriate point.</td>
</tr>
<tr>
<td>Misleading prototype demonstrations</td>
<td>Demonstrations give false sense of progress.</td>
<td>• Be cautious of innovator demonstrations – prototypes may appear further advanced than they are.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Have teachers run the demonstrations.</td>
</tr>
<tr>
<td>Target audience ignored</td>
<td>Initiatives work well in selected settings with Early Adopters, but not Mainstream users.</td>
<td>• Ensure that multiple collaborations and analysis inform broader needs.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Projects need to draw in mainstream users.</td>
</tr>
<tr>
<td>Projects remain uncompleted</td>
<td>Documentation or evaluation not completed; innovator focuses on technical aspects or adding new functions.</td>
<td>• Recognise need for additional support.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Monitor situation and judge when projects should be re-focused or terminated.</td>
</tr>
<tr>
<td>Project failure</td>
<td>Curriculum projects not completed on time; difficulties of new technologies underestimated.</td>
<td>• Ensure fall-back teaching approaches are in place.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Learn from a reflection on failures.</td>
</tr>
<tr>
<td>Design too complex</td>
<td>Technical or educational approach becomes too complex or elaborate for others to maintain or adopt; dependency on untested technology.</td>
<td>• Build anticipated support requirements into project formalisation.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Limit scope of project at early rather than later stage.</td>
</tr>
<tr>
<td>Misapplication of CDR</td>
<td>Informal approaches may be used simply as a production short cut; outcomes not aligned with organisational strategy.</td>
<td>• Recognise how CDR differs from systematic project production.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Consider risk, unexpected outcomes.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Maintain research–production balance.</td>
</tr>
<tr>
<td>Ownership</td>
<td>Intellectual property disputes; contributions not recognised; difficulty in opening up projects to others.</td>
<td>• Incorporate research activity as legitimate component of organisational learning model.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Formally acknowledge contributions.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Accept that agreements may not work.</td>
</tr>
</tbody>
</table>

The unpredictable progress associated with CDR may take a heavy toll on both developers and teachers, often connected with pressure to meet class deadlines (Jan 1992, Feb 1999). CDR projects often appear to continue as an endless cycle of experimentation, led by Innovators happy to explore new ideas or add features (Apr 1997). They may not be interested, or see the point in, ‘finishing off’ a project, for example, when their involvement is no longer appropriate (Jan 1994, Aug 1999). At other times, additional support may be required, but the nature of leading edge development makes involvement of others difficult (Jul 1998, Sep 1998).

CDR, is not a systematic production approach, rather, it is leading edge research seeking innovative generalised solutions to local teaching requirements (Section 11.4.2, 11.4.3). The institution must decide on the appropriate balance of research and production activities, depending on its resources and position in the educational market. Often, however, the value and nature of innovation may not be fully understood (Section 11.4.2, 11.4.3).

The intense involvement and tight control exerted by innovators during the prototype development, breeds a strong sense of ownership that, paradoxically, may threaten the likelihood of longer-term initiative success. A generic system will ultimately succeed only if ownership and responsibility is passed to others within the organisation. Management have a responsibility to guide this process, but recognise that Innovators may often be
frustrated by their position and perceive themselves as marginalised (Jan 1994, Section 11.4.1). Innovation needs to be appreciated as core university business, providing the institution with its competitive edge (Sections 6.3.2, 11.4.3).

13.2.6 Facilitating conditions for CDR

While the traditional process of individual academics researching their own teaching is generally well accepted and supported within universities, the extension of such research to generic CFL systems development is not well understood (Sections 1.2, 2.3, 6.3.2). If the collaborative approach promoted in the CDR model is thought to be relevant to an institution, then management should actively maximise returns from the investment. Some organisational considerations for supporting and guiding CDR are summarised in Table 13.5.

Table 13.5 Organisational strategies to support and guide CDR

<table>
<thead>
<tr>
<th>Effect</th>
<th>Effect</th>
<th>Associated organisational strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Defining organisational strategy</td>
<td>Fostering CDR and aligning goals with broad institutional aims.</td>
<td>• Identify place of innovation in organisational mission.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Provide funding opportunities to foster innovative teaching project grants.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Try positioning innovators in committees.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Foster cross-disciplinary research interests.</td>
</tr>
<tr>
<td>Changing workplace structure</td>
<td>Reorganisation of workplace structure focuses interest and capacity to engage in CDR.</td>
<td>• Define individual research roles and responsibilities.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Create a wider infrastructure to monitor and guide activities, e.g. working groups, committees, reporting processes.</td>
</tr>
<tr>
<td>Opportunities for collaboration</td>
<td>Maximising opportunities for effective collaboration.</td>
<td>• Publicise work of units and researchers through seminars, reports activities.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Recognise the eclectic nature of alignments.</td>
</tr>
<tr>
<td>Connecting with the community</td>
<td>Fostering connection with a broader community for feedback and ideas.</td>
<td>• Encourage presentations at seminars, conferences.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Encourage developer contact with teachers and even students.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Recognise the horizontal nature of collaborative networks.</td>
</tr>
<tr>
<td>Adequate resources</td>
<td>CDR requires on access to latest new technologies, sufficient time for development and adequate student IT resources.</td>
<td>• Accept that time is required for investigating new technologies.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Time relief for teachers.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Funding for necessary technology and local IT support.</td>
</tr>
<tr>
<td>Recognition and rewards</td>
<td>Role and contribution of innovators is not recognised or acknowledged adequately.</td>
<td>• Consider intellectual property aspects for conceptual designs.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Formally acknowledge contribution, recognising the difficult nature of the activity, e.g. in performance appraisals.</td>
</tr>
</tbody>
</table>

Clearly organisational strategies influence how Innovators in faculties and Central Units perceive opportunities for research directions and collaborations. The collegial culture and conditions in universities generally foster opportunities, but targeted funding programs can dramatically focus such activity (Oct 1991, Aug 1993, Nov 1996, Oct 1997, Jan 1999). Other organisational mechanisms to align the visions of innovators and organisation might include participation on appropriate committees (Jul 1992, Jan 1999) and targeted strategy plans (Sep 1996).

Central Units are best placed to build cross-disciplinary links and drive generic, rather than localised, solutions for CFL systems (Oct 1997). They may tend, however, to focus on production, evaluation and staff development, rather than more open-ended research. If Central Unit staff are indeed sanctioned to engage in CDR, the Unit should maximise its returns by guiding the research focus, clarifying roles and responsibilities, monitoring progress and integrating outcomes into its activities (Section 11.3.5). In particular, the shift from innovative prototype to packaged system needs to be carefully managed (Jan 1994, Aug 1999).
The establishment of effective collaborations between individual faculty and Central Unit staff is fundamental to CDR. These collaborations occur horizontally across departments and institutions; they are opportunistic and not easy to establish. They will be fostered opportunities for funding and by regular academic practices, such as seminars, conferences or visits to other institutions (Mar 1993, Aug 1993, Jan 1994, Aug 1999, Jun 2000).

CDR depends also on a diffuse network of contacts, through which ideas are interchanged, conceptual models articulated and feedback received. This may involve workplace colleagues, interested teachers, professional groups and individuals from other institutions. The involvement of a broad range of mainstream teachers is also critical if CFL systems are to reflect real world needs. Innovators may establish such contacts through their academic consultancy role and by participating in seminars, conferences or workshops.

Finally, formal recognition by Management of the contribution and problematic nature of innovative CFL research will facilitate more useful perceptions of its value to the organisation and maximise effective integration of innovations into mainstream activities (Jan 1994, Aug 1999, Section 11.3.5).

13.3 A developmental research case study: the Physiology ‘Group Project’

The above model of CDR was synthesised from available empirical evidence of workplace practice, portraying an external view of an innovation process. Part of that evidence came from the experience of one particular action research collaboration with teachers in 2000. That workplace experience offers a particularly useful exemplar of CDR practice, which complements the generalised theory portrayed within the model.

The particular case study concerns the collaborative action research development of the ‘Group Project’ in Physiology. This educational initiative to improve student skills in critical thinking and communication has already been detailed in Section 10.2.3. It was also portrayed from my perspective within the narrative history (Jan 2000–Aug 2000). In the following sections, it is described again as a specific instance of CDR from the perspectives of the collaborators, illustrating the localised nature of the setting, development process and products emerging from the collaborative research.

The following description draws heavily on published accounts of the development (Fritze, Kavnoudias et al., 2001b; Kavnoudias et al., 2000).

13.3.1 Collaborative development approach

The development of the Group Project was undertaken as an action research collaboration between Physiology teaching staff and myself as central developer (Fritze, Kavnoudias et al., 2001b, p. 907; Kavnoudias et al., 2000, p. 97). By constructing online activities each week, teaching staff were able to refine the activity design and content by reflecting on their observation of the students, tutor feedback and responses to evaluation questions from the previous week. I advised teachers on the design of OCCA activity pages, helped in their construction and developed additional functionalities for the OCCA system to meet emerging requirements.
The weekly production cycle is illustrated in Figure 13.4 (Kavnoudias et al., 2000, p. 97). The team considered the process reasonable, given that there were only two or three tasks each week, the content design was already in place (based on previous implementations of the activity) and because we had the safety net of a human tutor during each session. It was in line with previous curriculum projects in which development of materials and support frameworks were carried out in an iterative fashion during implementation (Fritze & McNaught, 1994, p. 864).

![Figure 13.4 Re-development process employed in the Group Project (after Kavnoudias et al., 2000, p. 97)](image)

The main pages for the Web site were produced after initial analysis and planning, based on the previous implementation (Section 10.2.3). Prior to each week of the course, the content team discussed the pages for the next week in the light of the preceding week’s experience. This came from observations of the students, feedback from evaluation questions embedded in the activities, and tutors. An end-of-semester evaluation and reflection completed the process. In comparison with the generalised model in Figure 13.3, this real life instance of CDR reflects local departmental realities of a specific curriculum timetable and course approach. As a practical action model, it does not need to relate either to the wider CFL systems development, which involves connections across other such projects. The process of consolidation at end of semester might be thought of as local ‘packaging’ of curriculum materials, but not of the OCCA system itself.

An indication of the interactions within the local ‘working community’ is given in Figure 13.5. The number of lines represents a subjective indication of the extent of discourse. For example, most of the day-to-day ‘action’ took place between Kavnoudias and me, which was recorded in reflective journals. These notes later informed the narrative history of the period in Chapter 11 (Feb–Aug 2000). Physiology lecturers Kemm and Williams provided teaching and curriculum oversight, guidance and course evaluation (Kemm, Williams, Kavnoudias & Fritze, 2001; Kemm, Williams, Kavnoudias, Fritze et al., 2001). Not apparent in this diagram is the critical involvement of Kemm in previous projects that had shaped the OCCA system (Oct 1997, May 1998, Sep 1998, Oct 1998, Nov 1998, Jan 1999). Other important communications also occurred with students and tutors assigned to different classes. Teachers from other faculties using OCCA in different curriculum projects were also indirectly involved, with their ideas passing through me. Staff from the Central Unit (MEU) maintained the
central OCCA database and provided technical support. As an interaction map guiding local action, this figure can be contrasted with the organisational view of the CDR model (Figure 13.2).

**Figure 13.5 Interactions within the ‘Group Project’ and OCCA development community (after Kavnoudias et al., 2000, p. 95)**

The multiple stakeholder perspectives associated with this development were reflected in three shared goals, bridging the specific requirements of Physiology teaching staff and the Central Unit (Fritze, Kavnoudias et al., 2001b, p. 907):

- **educational**: to produce and evaluate the Group Project as a computer-facilitated collaborative learning activity using OCCA;
- **understanding**: to increase collective understanding of pedagogical and delivery processes associated with CLEs; and
- **CFL system refinement**: to inform further development of the OCCA system through its application to a real teaching context.

These goals are closely linked to the dual focus of the generalised model on developing creative approaches to local curriculum problems and establishing generalised understanding and generic approaches (Section 13.2.1). Specific outcomes related to the three goals are described below as emerging educational elements, changes in our understanding and specific refinements to the OCCA system.

### 13.3.2 Emerging educational elements

The educational outcome of the collaborative development process was represented by the set of elements ‘crafted’ on top of the OCCA framework, forming a ‘toolkit’ of teaching resources used in later CLE activities (Table 13.6). These have since been applied in other areas (Margetts et al., 2002, pp. 130-1), but it is pertinent to point out that the ideas for some of these elements actually originated from previous projects (Fritze et al., 1998; Fritze et al., 2000). The elements characterise novel educational design features emerging within the collaboration research process (Mar 2000, Apr 2000, May 2000, Aug 2000).
<table>
<thead>
<tr>
<th>Educational element</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>‘Summary’ page</td>
<td>Single Web page collating student work, for example, over one week.</td>
</tr>
<tr>
<td>Learning ‘portfolio’</td>
<td>Weekly summary pages were expanded into a portfolio of summaries of the drafting sequence, students’ confident levels across the weeks and side-by-side comparisons of written work and key concepts (Mar 2000).</td>
</tr>
<tr>
<td>‘Introduction and schedule’ page</td>
<td>The timetable page evolved into a dynamic and personalised map of student work for the semester (Figure 10.4, p. 151). Progress indicators and icons made it the ‘central communication centre’, visited by the student each week.</td>
</tr>
<tr>
<td>Student self-assessment of open-ended questions</td>
<td>A self-assessment sequence of: open-ended question, self-assessment against criteria points, opportunity to redraft. Another page summarised the process.</td>
</tr>
<tr>
<td>Reflection on previous work</td>
<td>The portfolio and embedded references were used to display prior work as context for questions promoting reflection on learning.</td>
</tr>
<tr>
<td>‘Importing’ prior work</td>
<td>A special button to allow students to ‘import’ a previous response, or set of responses, into a text box for re-drafting.</td>
</tr>
<tr>
<td>‘Posting’ work to peers</td>
<td>With a simple button, groups could ‘post’ a piece of work to an anonymous peer group assigned by the tutors. The peers later ‘posted’ their review back.</td>
</tr>
<tr>
<td>‘Rubber stamp’</td>
<td>A ‘rubber stamp’ could be awarded by students to their peer group in the review; also used as feedback by tutors (Figure 10.6, p. 153).</td>
</tr>
<tr>
<td>Confidence indicators</td>
<td>Simple popup menus and comment boxes for students to indicate their degree of confidence in different tasks over the semester. Accessible by student or tutor in the portfolio and summary pages.</td>
</tr>
<tr>
<td>‘Key word’ prioritisation task</td>
<td>Specialised page enabling students to define and sort key points about the topic under investigation (Figure 10.5, p. 152). Recalled and re-drafted in later activities.</td>
</tr>
<tr>
<td>Facilitating ‘group discussion’</td>
<td>Set of topic points to stimulate discussion by the group. Each point could be rated for relevance and group consensus reached (to encourage reflection on the discussion process).</td>
</tr>
<tr>
<td>‘Administrator’ view</td>
<td>Teachers select different views of particular groups’ work and perform administration functions, such as unlocking submitted records (Figure 10.6, p. 153).</td>
</tr>
<tr>
<td>Tutor annotation ‘template’ (the ‘Editorial Board’)</td>
<td>Page showing the final essay, peer review and response of a selected group (Figure 10.6, p. 153). Teachers could efficiently scan through each group’s work and provide feedback via popup menus and comment boxes.</td>
</tr>
</tbody>
</table>

Most elements were simple Web page designs or small JavaScript components (Section 9.3.2), with the underlying educational conceptual model being of equal or greater significance than the technical design. For example, the ‘Learning Portfolio’ was simply a set of basic Web pages ‘collating’ a group’s work using simple OCCA tags (Appendix A4.3, p. 279). This was a powerful concept that was integrated into students’ reflective activities, but also used by the teachers to monitor student work. These educational elements evolved in both form and use, as our understanding developed over the weeks.

### 13.3.3 Changes in understanding

The second outcome from the collaborative development process was concerned with more subjective changes in our understanding, in the form of spontaneous revelations, unintended consequences, or paradigm shifts experienced by one or more of the participants (Table 13.7). These observations were gleaned from reflection on the journal entries, post-semester discussions and student work (Figure 13.4). They were often associated with emotions – excitement, interest or frustration – and were important markers of our developing personal conceptual models. The formal articulation of these normally tacit understandings may provide useful insights and promote discussion by others about the practical issues, emotional aspects and unpredictability of the real workplace environment.
Table 13.7  Examples of new understanding emerging from reflection on the development process

<table>
<thead>
<tr>
<th>Emerging understanding</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thinking about teaching, not tools</td>
<td>In shaping each activity, we found ourselves trying to think in terms of face-to-face interactions, e.g. writing, discussing and arranging pieces of paper on a table.</td>
</tr>
<tr>
<td>Serendipity</td>
<td>Delays in the programming of database reports prompted the development of the administrative page that delighted us with its usefulness. ‘Naïve’ users also provided ideas. A request to “paste in a picture” into the page made us think; after consideration the idea was not included for pedagogical, rather than technical reasons.</td>
</tr>
<tr>
<td>Value of effective teaching tools</td>
<td>Teaching staff were excited by the effectiveness of the tutor annotation Web page for reviewing and responding to students. The clear summary of the peer review sequence revealed great insights into the understandings and interactions of groups. The pre-defined tutor responses, which were progressively refined, made the process very efficient. The teaching staff crowded around the computer when doing this and the observation was made that the resulting process of reflection, discussion and consensus-building precisely mirrored the learning environment we were creating for the students.</td>
</tr>
<tr>
<td>Portfolios</td>
<td>Even though portfolios had been planned, all of us were delighted at their effectiveness in summarising a group’s work. To the developer, the simple Web frame structure meant that the teachers could easily extend the summary pages themselves. We realised this could be given to the student at the end of the course as a personal record of their learning. In Semester 2, however, we moved away from the ‘book’ structure, to provide access to the same summary pages via the matrix organisation of the overview page.</td>
</tr>
<tr>
<td>Changed perspectives via new views</td>
<td>Teaching staff were interested in how access to summaries of students’ work increased their understanding. They were surprised by the range of responses and variation in interpretation of the tasks by the students.</td>
</tr>
<tr>
<td>Value of seeing tools in real use</td>
<td>As the CFL developer, I was often present during the running of classes. I gained valuable insights from seeing the software in actual use and talking with tutors and students.</td>
</tr>
<tr>
<td>Time pressures</td>
<td>Completing the required activities each week often placed great pressure on staff due to illness, technical problems with software, or external factors. We would have preferred time to be able to stand back a little and respond to students or brief tutoring staff better. We needed time to reflect and were sometimes frustrated when we had no time to implement often quite small changes.</td>
</tr>
<tr>
<td>Change of direction</td>
<td>We originally planned to use immediate feedback in some tasks, but decided the reflective self-assessment tasks were of greater use to the student (and far easier to implement). Our conception of a learning portfolio changed from a linear collection of pages in a student ‘journal’ to ‘cross-sectional’ views of the learning experience accessed from the overview page matrix.</td>
</tr>
</tbody>
</table>

(after Fritze, Kavnoudias et al., 2001b, p. 910)

13.3.4 Refinements to the OCCA system

The third outcome from the collaborative development process involved refinements to OCCA functionality, which addressed emerging requirements of the project (Table 13.8, p. 230). These ranged from simple buttons or JavaScript components to more fundamental extensions to the OCCA system, implemented only after consideration of longer-term directions and needs of other projects. Examples of system extensions included new forms of user access and methods of posting. These system refinements represent an important contribution to the generic CFL systems development. A number of these, for example, the group and peer group functionality, were trialed in prototype form within the Group Project, before being engineered into the OCCA system by Central Unit programmers.

This case study represents an exemplar of collaborative developmental research that complements the generalised CDR model developed in Section 13.2. Together, these two views reflect the fundamental difference between theoretical/conceptual knowledge implicit in the model and situated/experiential knowledge gained from practice (Section 4.4). Implicit in these two representations is their dynamic relationship, by which
workplace experience has underpinned the model, which in turn guided the action research approach in a specific setting.

Table 13.8 Fundamental changes to the OCCA system arising from the redevelopment project

<table>
<thead>
<tr>
<th>Administrator &amp; tutor access</th>
<th>Ability for administrators to log on as any student in order to review their work.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group login</td>
<td>As we required students to sit together around the computer and create group responses, they needed to log in as a group, rather than as individuals.</td>
</tr>
<tr>
<td>Resources for different assigned cases</td>
<td>Each group required a ‘case question’ to be assigned by the administrator. The system then dynamically enabled certain pages according to the assigned case.</td>
</tr>
<tr>
<td>Peer group structure</td>
<td>Each group required a ‘peer review’ group assigned by the administrator.</td>
</tr>
<tr>
<td>Post work for peer review</td>
<td>Ability for a group to ‘post’ a record to the assigned peer group. This was then displayed in the second group’s pages for reviewing.</td>
</tr>
</tbody>
</table>

(after Fritze, Kavnoudias et al., 2001b, p. 910)

13.4 Summary

This chapter reports on the third and final goal of the study, to construct an organisation model for the development of innovative CFL systems. This was presented in two parts: a theoretical model and case study of developmental practice.

A model of Collaborative Developmental Research (CDR) was constructed from empirical evidence in the study, including the Developer-centred Innovation Model, narrative history of workplace experience and action research case study. CDR was defined as a collaborative approach to the development of innovative centralised systems for CFL in a tertiary institution. This is a form of research, seeking to extend technical, educational and institutional horizons with innovative CFL approaches, fostered by leading edge application of ICT. Central to the model are its dual goals to solve local teaching problems and enhance generalised understanding and action within the organisation.

CDR straddles top-down ‘expert’ production and bottom-up academic research into education. It harnesses the drive of innovators in central CFL systems development and academic early adopter-innovators in faculties. While driven by key individuals, a strong community network is associated with the CDR process, connecting university and central unit management, mainstream teachers, central unit colleagues and external networks of individuals from other institutions. The collaborations established were characterised as horizontal in nature and opportunistic in their formation.

Six key stages in the CDR process were identified: initial investigative activity; formalisation of the initiative; cyclical prototype development; reflection; identification of turning points; and packaging for wider adoption. Within various stages, different community members are involved, with management playing a key role in fostering opportunities, guiding alignment with institutional visions, monitoring problems, identifying the need for re-direction and strategically drawing in other participants when required.
Particular difficulties drawn from the evidence in the study were noted. Many of these related to the control exerted by the innovator – necessary in order for leading edge initiatives to respond to changing understandings and technical complexity. Problems from an organisational perspective included difficulty in determining how far a development had actually progressed, projects that did not fully consider the ultimate users, designs that are too complex and conflicts over ownership of ideas. CDR contrasts with more systematic approaches to the production of curriculum materials or CFL systems. While both have their place, the organisation needs to find a balance that suits its academic and organisational culture.

The emerging organisational model of CDR was complemented by a localised case study of collaborative research in a particular curriculum project. The development process was portrayed from the perspectives of teachers and the developer as an action research approach sharing three goals: to produce a particular learning activity; to increase understanding of CFL; and to inform further development of the OCCA system. Key to the success of this project was the capacity afforded by the OCCA system for day-to-day teaching requirements to be articulated efficiently.

Together the CDR model and exemplar case study reflect the fundamental difference between theoretical/conceptual knowledge and situated/experiential knowledge. These forms of knowledge exist within a dynamic relationship in which workplace experience informs development of theory, which in turn guides practical action.
CHAPTER 14. Discussion and Conclusions

Figure 14.1 Contribution of Chapter 14 (bold) within the thesis structure of Figure 2.2

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  14.2.2 Limitations to the development .............................................................................................. 236
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14.1 Introduction

In this concluding chapter I will draw together the components of the study and discuss the significance of the outcomes of the three main goals: software production, understanding of the workplace experience and an organisational model of CFL (Computer-Facilitated Learning) systems innovation. The achievements of each goal are discussed under a series of topical themes, the limitations to the research are identified and areas for future research are proposed.

An overview of the thesis is then provided by locating the software and theoretical outcomes within an organisational framework, which relates the roles of students, teachers/innovators and management/support staff. From this viewpoint, the thesis outcomes are seen not as defined products, but as interfaces – to facilitate individuals’ understanding of their situation and their ability to improve the situation of others.

Finally, the main conclusions drawn from the study are summarised.
14.2 A generic online learning system – a discussion of the production outcomes

The first stated goal of this study was to re-develop an existing CFL software package (TutorialTools) using Web technology (Section 2.3.1). This was to be a ‘generic’ product that could be maintained centrally and would meet learning and teaching requirements across all disciplines. I applied an action research prototyping approach in this development.

The outcomes of the software production were reported in Chapters 9 and 10. I showed that while the same basic aims for the product were maintained, the functional and technical design evolved significantly through a series of prototype phases into the final form of the Online Courseware Component Architecture (OCCA). These functional characteristics were identified and related to the requirements of user-active learning and teaching environments. Two case studies of the implementation of OCCA within departments demonstrated how this functionality could empower teachers to craft innovative solutions for their respective teaching needs. Wider adoption of OCCA across the university was surveyed in 24 curriculum projects, revealing its use as a tool for departmental teaching staff, as well as a project development system for expert developers.

In the following section, I will discuss the significance of this software product under the theme of its emergent constructivist design, relating in particular to Squires’ (1999) notion of ‘subversive use’ and ‘volatile design’.

14.2.1 A constructivist outcome: subversive use and volatile design

A constructivist view of learning, which underpins this study, suggests the need for open-ended, exploratory learning environments in which the learner can develop personally meaningful and transferable knowledge (Squires, 1999, pp. 48-9). Every CFL software design, however, will encapsulate to some degree the developer’s interpretations of learning requirements, which may not necessarily reflect local perceptions of needs. That is, there is an attendant risk in designing educational software that it may adversely “constrict the levels of freedom necessary for learners to make decisions about their own learning” (Squires, 1999, pp. 48-9).

Depending on the context of use, it is likely the teacher will need to customise, re-invent, or even ‘subvert’ the intended use of the software. The term ‘subvert’ suggests the possibility for the teacher, who is ultimately responsible for their own teaching, to critically challenge models imposed upon them by technologies and by interpretations of their situation made by others. For example, simple multiple choice exercises might be used by a teacher to trigger discussion within a student group, instead of the individual drill and practice the program developers probably had in mind. This suggests that if we accept a constructivist approach to development (Section 5.2.2), then the software design should actively consider the user’s flexibility and freedom, rather than focusing on constraint or ‘teacher-proofing’. Such flexibility encourages re-invention of products to meet local conditions or respond to emerging problems, ultimately strengthening the likelihood of adoption and success of the innovation (Section 6.4.1). The incorporation of opportunities for ‘subverting’ the original intentions of a software design by its users leads to designs that are ‘volatile’ in nature and can “respond to the changing and idiosyncratic needs of learners” (Squires, 1999, pp. 48-9). It is not simply a matter of pre-empting a range of possible user choices, but acknowledging the transformative potential of the product to impact in a manner beyond the designer’s conceptions. A constructivist CFL system will thus foster opportunities for ‘double-loop
learning’ by users, who are able to critically reflect on and adjust their underlying assumptions about learning (Section 6.3.1).

As a tool used by teachers to create their own online learning environments, I contend that OCCA exhibits a high degree of design ‘volatility’, as expressed in its flexible educational constructs, technical implementation, capacity for involvement and modular structure. Such flexibility increases teachers’ perceptions of control of their own situation, making their adoption of a transformative approach to teaching more likely (Section 6.5).

The nature of the design volatility of OCCA can be explored by comparing its characteristics with those of the original TutorialTools system (Table 14.1). On the surface, these products displayed similar fundamental learning aims: rich, customisable educational structures; views of student learning; accessibility to teachers; support for a community of users; modular and reusable structure; and standardised protocols (Section 9.2.2). TutorialTools, however, was a self-contained software application whose operation was specified by pre-defined question styles, optimised for the specific teaching purpose and discipline environment in which it was designed (Appendix 3, p. 275). OCCA, on the other hand, acknowledges the diverse and unfolding perspectives on learning and teaching in multiple project settings across all disciplines. Design volatility has become its central tenet. The dimensions of this volatility are discussed below.

Table 14.1 Characteristics of the design ‘volatility’ of the OCCA and TutorialTools developments

<table>
<thead>
<tr>
<th>Design volatility in:</th>
<th>TutorialTools</th>
<th>OCCA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Educational constructs</td>
<td>Choice of question type, sequence and content.</td>
<td>Optimised environments and activities for both learning and teaching created locally.</td>
</tr>
<tr>
<td>Technical implementation</td>
<td>Single HyperCard application.</td>
<td>Simple Web pages with optional JavaScript functions or interactive objects connecting with a central database.</td>
</tr>
<tr>
<td>Levels of staff involvement</td>
<td>Teachers select from options and enter content. Reports of student responses generated.</td>
<td>Teachers craft Web pages or re-use existing ones; tutors monitor students and provide online feedback; programmers develop additional functions.</td>
</tr>
<tr>
<td>Modularity of structure</td>
<td>Questions and modules can be re-used.</td>
<td>Course site designs, learning activity pages, page components and educational ideas can be shared.</td>
</tr>
</tbody>
</table>

Volatility in educational constructs

OCCA imposes no pre-defined structures for either learning or teaching and moreover, makes no technical distinction between students, tutors or teachers (Section 9.3.1). These fundamental assumptions are congruent with Laurillard’s Conversational Framework for learning, in which students and teachers are complementary contributors to the learning process: articulating, reflecting and adapting their understandings (Section 4.5.1). By using these basic user transactions as building blocks, creative solutions to local requirements for academic learning can be crafted on top of a robust framework (Section 9.4). OCCA provides a catalyst to subvert traditional conceptions of CFL. For example, there is no technical reason why student and teacher roles could not be reversed, so that students could assess and/or provide feedback to teachers on the effectiveness of their teaching and CFL materials design. That is, the absence of pre-defined models of role and interaction embedded in typical learning management systems, such as WebCT or TopClass, enables teachers to explore and express new conceptions of an online environment and to challenge the conventional ‘wisdom’ of their peers and educational developers.
Volatility in technical approach

From a technical perspective, OCCA supports a high degree of implementation flexibility. While the original system design was locked into a highly interactive development environment (Shockwave), I ultimately concluded that such dependency was problematic and that a flexible and open-ended system could only rely on ‘standard’ Web page functions. OCCA sites are constructed from basic Web pages, but may be extended with JavaScript, Shockwave, Flash or Java objects, to whatever level of complexity is appropriate (Section 9.3.2). Integration of these multiple technologies centres on the specification of the ‘State Description Protocol’ through which any form of learning transaction can be stored and recalled (Section 9.3.1). This flexibility means that highly interactive simulations or tools can be integrated into the learning experience. The emergence of design volatility was seen in the profound shift in technical approach, from a highly interactive learning application, to a low-level systems architecture (Section 9.2.2).

Volatility in involvement

OCCA’s design volatility is also evident in the multiple levels of engagement possible for teachers and support staff. My original intention was that the system would be a tool for teachers. Somewhat unexpectedly, Central Unit and external contractors now use it as a ‘programming environment’ for constructing curriculum projects on behalf of teachers (Section 10.4.1). In fact some 15 different roles can be associated with the use and support of OCCA-related projects interacting with the system in different ways; for example, five distinct levels of programming role were identified (Section 10.4.4). Rather than seeing OCCA as just a tool to be applied, it can be more viewed as a catalyst for reconceptualising technical, teaching and support roles for particular implementation contexts. This means that departments can determine their own infrastructure for engaging with the OCCA system, depending on their resources, skills and educational culture.

Volatility in modular structure

Lastly, modularity and the re-use of software components has been a high priority throughout the development (Section 9.2.2). Modularity within OCCA, however, occurs at a number of levels. The granularity of components, for example, varies widely from elements inserted in Web pages, interactive multimedia objects, pages and sets of pages, up to complete subject sites. Transferable educational constructs are also emerging, such as the notion of a Collaborative Learning Environment, student ‘portfolio’, ‘rubber stamp’ or ‘overview page’. These may or may not have a clear physical form, but can be usefully communicated between users (Section 13.3.2). That is, there is an evolving understanding of what defines a ‘learning object’ within OCCA.

In summary, the significance of this software production relates to its inherent design volatility, which empowers users to conceive learning and teaching structures that go beyond what I, as the developer, could ever conceive. This quality reflects the criterion of ‘transferability’ in constructivist research, that is, the ability of others to apply its ‘findings’ in other contexts (Section 7.7.2). In this sense, the onus of judging suitability and making adaptations for particular teaching contexts has been handed from the system developer to users (both teachers and other developers). This system quality has been achieved only through extensive engagement with innovative teachers and prototyping of multiple projects over four years, from which a common design foundation could be factored.
14.2.2 Limitations to the development

An action research model of inquiry informed the development of the generic CFL system. Within the academic environment, however, my ability to formally engage academics in collaborative research was restricted. From my position as a developer in a central unit, it would have been inappropriate, in most instances, to attempt to turn curriculum developments into ‘research’ projects. The funding program under which most projects originated clearly focused on production, rather than research. While teachers were well aware of my work on a generic CFL system, this restriction on building a more collaborative relationship limited opportunities for joint reflection and gathering of data that would have better represented the experience of teaching staff. One particular action research collaboration that did emerge is reported in Section 13.3.

Programming and administration of the central OCCA database and server was undertaken by colleagues in the Central Unit and carried out in conjunction with other Unit projects (Section 11.5). This meant that I was not able to fully implement planned designs, for example, for a more a generalised definition of user ‘groups’ and relationships.

By the conclusion of my involvement in the software development in 2000, ‘packaging’ for different community use had emerged as a requirement (Section 13.2.4). This was simply beyond the scope of this study and required the involvement of other Central Unit staff.

14.2.3 Future research directions

Given the potential identified in this study for OCCA to transform learning, teaching and development environments within the University, I can only hope that support and ‘packaging’ of the system for wider use within departments will continue. This will require the identification of different user and support roles, and the establishment of an appropriate infrastructure. My experience of attempting to ‘seed’ OCCA into wider use was that its very strength of design volatility muddied the perceptions of potential users of its relevance for them. I recommend that:

- the potential roles suggested in Section 10.4.4 be further explored to map perceptions of ‘usefulness’ and ‘ease of use’ for each level of involvement;
- based on the identified perceptions, packaging of exemplar activities and resources should continue, targeting ‘expert’ departmental support staff and mainstream teachers in particular (currently being undertaken in the ‘ILK’ and ‘ReaLT’ projects noted in Section 10.3.5);
- the development of a range of exemplar learning activities and teaching pages should continue in conjunction with innovative teachers, so that mainstream teachers are able to set up and run activities from a Web-based interface;
- further systems development should be continued to streamline the administration of OCCA sites by departments and the Central Unit; and
- the relationship of OCCA to other University learning management systems should continue to be monitored and ways for such systems to work together investigated.
This packaging will require commitment by the Central Unit to establish the most effective boundaries for support, as well as from local departments and faculties to provide the necessary resources and support for their own teachers.

14.3 Understanding the workplace experience of development – a discussion

The second goal of this study was to increase understanding of the workplace experience of CFL systems development. I applied a grounded theory approach to the interpretation of historical documents, software artefacts and journals related to the development of OCCA between 1996 and 2000. This was extended to a second case study of the TutorialTools development between 1991 and 1994, drawing on available historical data. Six strands of interpretive analysis were applied to produce bracketed representations of this experience in the form of:

- a narrative history of events told from a personal perspective (Sections 11.2, 11.3);
- alternative perspectives on the development experience elicited from a range of stakeholders (Section 11.4);
- a quantitative analysis of key categories and dimensions emerging from the data (Section 12.2);
- a visual mapping of patterns of phenomena (Appendix 4);
- a deconstruction of workplace activity from the evidence (Section 12.3); and
- a Developer-centred Innovation Model of CFL systems development (Section 12.4).

In the following discussion, I will draw these views together under themes of workplace authenticity, theory and practice of development, and the place of ‘evocative’ studies. This is a relatively unique longitudinal qualitative investigation of workplace practice associated with a major software production. The nearest equivalent investigation I could locate was a PhD study by Chaisson (1996). This was a major longitudinal investigation of two software system developments, similarly driven by a developer/researcher/programmer working in collaboration with users in a health-based research environment. He describes the unfolding history of events and organisational conflict in story form, from the perspective of the developer, and relates this to the action research model he applied. It is an indication that educational technologists interested in organisational impacts and systems development must be prepared to step outside established discipline paradigms (Section 3.4). Some elements of this study are used to frame the discussion below.

14.3.1 Workplace authenticity

Chaisson points out that act of research into workplace practice may itself compromise the authenticity of the setting under investigation. For example, action research studies instigated by a researcher may introduce different goals, priorities and activities to those of other organisational participants (Chaiasson & Dexter, 2001, p. 96). This is especially likely in the case of student researchers, who may favour ‘interesting’ or ‘ambitious’ topics and adopt a timeframe and level of involvement meeting their educative requirements, rather than those of the workplace (Chiaasson & Dexter, 2001, p. 104). Thus, to the organisation, the offer of student researcher commitment and expertise may represent an ‘innovation subsidy’ for a major systems project not otherwise feasible. While a potential benefit, this may distort the ‘authenticity’ of the workplace and indeed, the project many prove unsustainable in the longer term once the subsidy ‘expires’.

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The issue of workplace authenticity in my study is addressed in a number of ways. Firstly, the two case studies examined were instigated within the scope of my regular full time employment and consistently supported by University management at different levels (Section 1.4). Secondly, by clearly separating the study goals, the interpretive analysis was undertaken largely independently of production activity. Thirdly, the Mixed-Methods methodology emphasised a pragmatic interpretation of approach, to account for the complexity and real life requirements of the development (Section 7.3). That is, development decisions were not driven by a need to adhere to a rigid theoretical approach in order to satisfy a research requirement. The analysis shows indeed that work practices in the pre-study TutorialTools development and the generic system development shared many of the same characteristics.

The experience examined is therefore a reasonably ‘authentic’ workplace setting reflecting the particular environmental dimensions and collegial academic culture of the University of Melbourne in the 1990s. Authenticity in major system developments is associated with complex designs, multiple stakeholders, different goals and means, legacy systems, uncertainty in technology and ‘emergent shocks’, which may make longer term plans and development work irrelevant (Chiasson, 1996, pp. 150, 156-7). While it may well be “initially disturbing to admit”, emergent design, that is, adjustment of plans and approaches during a project, is an important characteristic of significant software development projects (Chiasson, 1996, p. 162). Indeed, the appearance of project ‘emergence’, for example, the evolving project descriptions in Section 9.2.2, is an indicator of the degree of innovation in the development process.

While the findings describe an authentic workplace, I cannot presume, however, that they can be generalised to other time periods or settings – only that by maintaining the richness of contextual detail, it is possible for others to make judgements about applicability in other settings (Section 7.7.2).

14.3.2 Models for inquiry – yes, but what do developers actually do?

The relationship between a theory of development and what developers actually do is a recurring theme promoted by a constructivist worldview. This resonates with Argyris and Schön identification of ‘espoused theories’ of action and ‘theories-in-use’ (Section 6.3.1) and Laurillard’s Conversational Framework, which emphasises the interplay between tacit knowledge and the second order representations through which ideas are communicated (Section 4.5.1). Indeed, the constructivist foundations for this study stress the need for new development models that account for the personal experiences and cultural setting of developers and educators and that recognise the uncertainty, ambiguity and chaos of cultural systems (Section 5.2.2).

While a ‘professional’ approach and evaluation of outcomes are emphasised as requirements for successful CFL initiatives (Section 1.3), contextual and social factors that shape practical decision-making are rarely critically investigated. The incorporation of a grounded analysis of workplace experience in this study therefore provides a valuable opportunity to explore the relationship between an espoused theoretical approach and what actually occurs in practice.
The general form of Information Systems action research discussed in Section 7.4.2 suggested a five-phase iterative process. On the surface at least, the dimensions of workplace activity emerging from the grounded analysis (Table 12.1, p. 192) can be aligned to these phases:

- diagnosis (consulting, investigating);
- planning (planning, discussion, negotiation, funding);
- action (instructional design, programming, implementing, collaborating);
- evaluation (reflection, evaluation, rethinking, reconceptualising); and
- specifying learning (writing, presenting, promoting).

There is also evidence of the iterative nature of the development, for example, the investigative activity at the commencement of both case studies in 1991 and 1996 (Section 12.3.2) and iterations in prototypes initiated by major re-conceptions in thinking. Weekly cycles of collaborative development, implementation, reflection and refinement were also revealed in curriculum projects (Section 13.3.1).

Such factors, however, lie buried within complex patterns of interaction reflecting the technical and social complexity of multiple project settings. While the action research model can be adjusted to accommodate such variability by allowing for ‘multiple’ goals, ‘fluid’ structure and ‘varied’ degrees of formalisation (Section 8.3), such generality limits its practical guidance and responsiveness to complex unpredictable environments.

Chiasson and Dexter conclude that the form of information systems prototyping he applied was unable to resolve the “structural conflict” or competing participant goals that arose in his study (Chiasson & Dexter, 2001, pp. 101-4). While they suggest that other action research methods “may have been more effective”, I would argue that this is easier to say with hindsight than in the planning stage. That is, a model of inquiry may be selected to ‘guide’ a research approach, but the unfolding human situation may well require an openness to revisit that choice. This reflects the pragmatic Mixed-Methods approach adopted in this study (Section 7.3).

While the development approach within this study was guided by an action research model, it is clearly apparent that the researcher and other stakeholders were strongly influenced by other models and organisational frameworks (Table 14.2).

Table 14.2 Existing workplace and external models potentially impacting on the development experience

<table>
<thead>
<tr>
<th>External model</th>
<th>Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Institutional funding programs</td>
<td>Initiated investigations of project opportunities, formal project specifications and reports, programming contracts.</td>
</tr>
<tr>
<td>Institutional management policies</td>
<td>Required written reports, participation on committees, performance appraisal processes.</td>
</tr>
<tr>
<td>Faculty teaching program</td>
<td>Structured programming and implementation around semester and weekly timetables.</td>
</tr>
<tr>
<td>Seminars and external conferences</td>
<td>Provided a structure for writing, presentation and reflection through peer discussion.</td>
</tr>
<tr>
<td>External developments in technology</td>
<td>Initiated investigation of new possibilities, triggering reconceptualisation of approach.</td>
</tr>
<tr>
<td>Home life</td>
<td>Provided a structure for reflection, effectively subsidised workplace production.</td>
</tr>
</tbody>
</table>

Table 14.2 indicates how external factors, such as University funding programs, semester timetables, new developments in technology or conference programs, impacted on the development process – more obviously than any specific research or production strategy. Further, it would appear that individuals act within multiple
models, according to their interpretation of their situation. For example, I may have viewed consultations with teachers in the context of my action research model of Figure 8.4 (p. 107), while teachers would have seen this as an aspect of an organisational support model. Critical differences in perceptions of processes emerged in reflections on the narrative history by different stakeholders (Section 11.4).

The study reveals in addition very similar patterns of workplace experience observed in the TutorialTools development (Section 12.3, Appendix 9, p. 290), which espoused no specific research methodology, and the action research development. This implies that multiple external effects and personal models of work practice dominate the day-to-day decisions of developers, far more than any single development theory or methodology.

Generalised models of inquiry are important as conceptual representations of particular approaches. They foster community discussion and offer a ‘best attempt’ to guide research decision-making. Any single model, however, cannot be expected to adequately account for the unpredictability of workplace situations and the multiple perspectives of stakeholders (Section 3.4). They compete with other generalised representations, as well as workplace models of action and tacit knowledge generated within the context of practice itself. While the action research prototyping method applied in this study was adjusted to reflect the inquiry setting (Section 8.3), with increasing fidelity comes decreasing transferability to other contexts.

In this study, a strategic bridge between generalised theory and practical action is formed by the grounded analysis of the workplace situation. The development of grounded theory is a practical means of making sense of complex and emergent situations and to ‘discover’ unexpected phenomena and relationships that can then be related to other evidence and to generalised theories (Section 7.5.1). In the context of the inquiry, generalised theories have no higher status than empirical evidence and are informed by, and inform, emerging understandings.

The complexity of addressing the dual ‘development’ goals of software production and qualitative understanding of ambitious information systems development makes studies of this scale uncommon and significant (Section 2.3). As such, they must serve as landmark studies to inform further practice and theory generation. Major developmental studies can be usefully compared to meta-studies. Both are significant undertakings, but where a meta-study takes a holistic view of patterns of activity across multiple studies, the interpretive developmental study looks at patterns of activity from different perspectives within a single contextual setting. The inherent multi-disciplinary nature of such studies creates challenges, not only in analysis complexity, but also in their bridging of multiple research and professional communities. CFL literature, for example, rarely cross-references Information Systems literature in which Chaisson’s study is located, yet such a study is pertinent to the observed difficulties of CFL organisational adoption and culture (Section 7.4.2).

With the commitment to acknowledge workplace authenticity comes a blurring of traditional research community boundaries and methodologies.

**14.3.3 The nature and importance of ‘evocative’ studies**

The acknowledgement of multiple stakeholder perspectives in this study reflects its constructivist foundations (Section 7.2). Firstly, alternative perspectives of other stakeholders have been sought through reviews of the
narrative history and within the collaborative action research project (Sections 11.4, 13.3). Secondly, the different analyses within the study are specifically targeted at different communities. The narrative history in Chapter 11, for example, is in presented in plain English to be inclusive of all possible stakeholders; Chapters 9 and 10 would be of interest to OCCA users, Appendix 4 (p. 278) is for more technical users and Chapter 13 is aimed primarily at organisational managers. The third aspect discussed below refers to future knowledge generation by others as a consequence of the study.

Representation of a complex technical and human history spanning nine years in the narrative personal history is a major component of the analysis. What is of particular interest is the capacity of such a representation to evoke a sense of the human issues, drama and relevance to the individual reader. Thus, when reviewed by teachers, colleagues, managers and family members, alternative perspectives on the workplace experience were elicited (Section 11.4). Readers constructed meaning according to their background, interests and connections to the development setting. Although the narrative reflects my view and interpretation of events, I attempted to make no overt judgement, merely to relate what I saw through a systematic analysis of what data I had available (Section 8.4.6).

*Evocative* reports can provide a powerful political mechanism to foreground critical, but often hidden issues bridging diverse communities. They can cut across arguments for economic efficiency and accountability, fostering reflection and deeper understanding by participants at multiple levels, both inside and outside an organisation (Section 6.2). It is cause for concern, for example, that CFL research and evaluation publications rarely critically address workplace issues – despite clear indications that time, workloads and conflicting academic priorities are the most significant issues currently facing academic staff (Fritze, 2002, p. 17).

The narrative history is bracketed by further representations in the form of emerging dimensions, visual maps of phenomena, quantitative breakdowns, correlations and illustrative case studies. Together these provide a source of rich social, technical and organisational data, which can be the subject of further analysis and can elicit conceptualisations by others that *go beyond* the interpretations and preconceptions of the original researcher. Interestingly, the evocative character of the interpretive analysis is congruent with the design volatility exhibited in the OCCA system itself (Section 14.2.1). Both reflect the constructivist philosophy that underpins this study.

14.3.4 Limitations of the analysis of workplace experience

The TutorialTools case study in the period between 1991 and 1994 relied on limited historical data, compared with the later case study during which personal observations and reflections were maintained. Even then, my ability to maintain consistent entries in personal journals varied with pressure of work, reflecting the precedence given to production priorities.

There were practical and ethical limitations sourcing organisational data that was not directly accessible to me. Organisational events and issues used in the analysis were therefore restricted to those with which I had direct involvement.
The creation of a narrative history required a balance between readability and detail, which involved a necessary compromise over which incidents and project involvements would be included (Section 8.4.6). For example, certain project collaborations and events in the data were omitted or underplayed.

The study is highly contextualised in terms of the settings, time periods and individuals involved. That is, I cannot claim the model of innovation portrayed will be predictive of what might happen in other contexts. For example, even within the same University, CFL funding strategies have significantly changed since completion of the study (Section 11.4.3).

Finally, for most curriculum projects associated with this study, it would have been inappropriate for me to approach teachers with an action research proposal. Indeed, the funding application process upon which much of this involvement was based formally focused on production, rather than research. The analysis therefore primarily reflects a view of innovation from the perspective of the central developer.

14.3.5 Future research and directions

This study has piloted a methodology for evocative representations of social histories of CFL developments. There is enormous scope to expand this approach into more regular organisational practice. It may not be apparent, but my decision to publicly reveal my personal experience was not undertaken easily. This is an approach that will only work if a culture of honesty, openness and mutual respect is carefully nurtured. Possible ways in which this might be consolidated include:

- extending reflections on the existing narrative history to a wider range of stakeholders in faculties and the Central Unit, as well as people external to the process altogether;
- investigating methods for efficient generation of narrative history as a regular aspect of workplace practice, for example, through data gathering processes and reflective practice; and
- using narrative histories within professional development programs, to foster discussion and understanding of critical issues.

I strongly recommend that individuals who consider themselves innovators in either teaching or CFL development, actively consider and foster their relationship with the organisation. For example, the routine recording and representation of their own workplace histories may address issues, such as lack of recognition and frustration by:

- providing evidence of their level of involvement and contribution, not visible within formal organisational channels;
- facilitating individual and collaborative reflective practice; and
- facilitating organisational understanding of the innovation process.

Gathering such data represents a starting point. The presentation and dissemination of these grounded perspectives for the benefit of both innovator and broader community, however, are critical. For example, traditional academic publication forums tend to play down any representation of personal factors, problems experienced or longer-term histories of complex (authentic) projects. It would appear that such evidence needs to
not only be gathered and represented effectively, but also seen as of value to the institution for monitoring trends and unexpected effects within the workplace to inform strategic policy.

Additional major longitudinal studies into workplace experiences of teaching and development should provide evidence of common factors across different settings. Given the effort and time required, however, these will remain uncommon.

14.4 An organisational model for Collaborative Developmental Research – a discussion

The final goal of this study was to build an organisational model to facilitate innovation in generic CFL systems development. Over the course of the study, my conception of such a model shifted from the clearly specified development processes, products and roles exemplified in Figure 1.3 (p. 10), to a generalised portrayal of innovative research practice, seen from an organisational perspective. This view was synthesised out of a developer-centred view of workplace experience (Section 13.2), participant perspectives emerging in a collaborative action research project (Section 13.3) and alternative perspectives of internal and external stakeholders evoked by the narrative history (Section 11.4).

A process of ‘Collaborative Developmental Research’ (CDR) was proposed as a form of research and development suited to universities, which capitalises on strategic collaborations between innovative teachers and innovative central systems developers. The purpose of this research is therefore, to implement local curriculum innovations while simultaneously informing leading edge generic systems development. It is distinct from both systematic production methods and traditional academic educational research carried out in local settings. Net returns from CDR to the organisation, and to innovators themselves, will be strengthened by appropriate organisational support and direction. To this end, the model draws on the empirical evidence to portray the participants, process stages, problems and facilitating conditions, in order to assist understanding and decision-making by those outside the process.

Fundamental to organisational understanding is appreciation of the apparently idiosyncratic nature of such research. This is both a strength, in its potential for true innovation, and a weakness, in its disconnection from regular organisational processes. It appears that there is a failure of institutions to integrate this creative energy into change at the broader institutional context and instead, outcomes appear as pockets of isolated activity (P. G. Taylor, 1998, pp. 272-3). From the organisation’s perspective the challenge is to “move beyond innovation at the level of individual subject…to change at the institutional level—the reinventing of cultures”. The following discussion picks up these themes.

14.4.1 The loneliness of the long-distance innovator?

Taylor (1998) draws attention to evidence that the development of new CFL environments has been primarily energised and enacted by ‘lone rangers’ – individual academic teachers highly motivated by their desire to improve the accessibility and quality of their teaching. Their approach reflects traditional academic autonomy; they work independently, un-fenced by policy frameworks and, while support is welcome, direction is not. Lone
rangers are commonly portrayed as the individuals who are not team players, work against and/or in spite of organisational frameworks and receive few rewards for their efforts (P. G. Taylor, 1998, pp. 272-4).

The lone ranger view is perhaps not unreasonable. It reflects the observed gap between the cultures of innovators and later adopters and implies a plausible reason why innovations have not been more successfully disseminated (Section 6.4.5). I suggest, however, that this view may reflect organisational expectations rather than specific insight into the actual workplace situation. The evidence in this study has revealed an innovator operating, not independently, but within an extensive horizontal network, forged across and outside the institution (Section 13.2.3). Although not a ‘team’ recognised within the formal organisational structure, this network of key collaborators, colleagues, managers, teachers and broader reference group, was purposefully cultivated to address the complexity of the task at hand. Similarly, the lack of rewards are seen in the context of traditional organisational expectations; the evidence shows how motivation is derived by the intrinsic satisfaction gained from this mutually supportive community, as well as the process of discovery itself. The study portrays this as continuous exploration, or even ‘play’, with new technologies and ideas and strong personal drive to push through significant problems associated with ambitious undertakings.

Individual innovation is the focus of many dissemination programs (Section 6.4.3), which focus on ‘appropriation’ of the identified ‘products’ of lone rangers (P. G. Taylor, 1998, p. 275). I question this emphasis on individual academic experimentation as the starting point for innovative organisational solutions (Section 6.3.2). The contextualised nature of such products may well make them fundamentally unsuited to wider uptake, no matter how successful they were in the local setting and what action is taken afterwards by the organisation to facilitate their diffusion (Section 6.4.5). I contend that innovation in generic CFL approaches should involve creativity in educational approach and organisational adaptability. That is, an innovation developed through joint collaboration between central developers and teaching innovators is likely to better align with broader institutional needs than one developed for local teaching requirements and later ‘packaged’ for generic use. This study clearly identified the evolving generic quality of the CFL system emanating from such collaborations (Section 9.2.2).

Finally, it is important to point out that conceptual designs and technical knowledge were clearly carried between otherwise independent projects by the innovator over a long time period. The implication is that organisations interested in fostering leading edge CFL development may do well to focus on the role and continuity of such individuals as organisational innovation generators, rather than just on the specific projects and project outcomes. It is likely that more benefits are derived indirectly from innovative activity than outcomes associated with specific projects. The CDR model attempts to map these patterns of activity so that those outside the process can better judge these effects.

**14.4.2 Limitations**

The CDR model is limited in its representation of organisational processes and structures. The data used in the grounded analysis did not extend, for example, to more structured interviews with organisational members or surveys that would have established more comprehensively organisational perceptions and histories. The model is my best attempt to turn around my perceptions of how the organisation impacted on me as portrayed in the Developer-centred Innovation Model, to view this ‘from the other side’.

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The model is drawn from activities of one particular innovator/developer, augmented by an academic collaboration in one discipline area. No claim can be made about its representation of other contexts and the decision of transferability must be left to the reader to judge in each specific case. To this end, the model is linked to illustrative descriptions within the narrative history.

An evaluation of the full costs and benefits associated with CDR was beyond the scope of the study. While some curriculum case studies were examined in detail, the analysis did not extend to comparisons with other development approaches or attempt to assess their full impact within the departmental settings.

14.4.3 Future research and directions

The CDR model is an attempt to facilitate practical understanding of CFL systems research by organisations to inform management strategies (Section 6.3.2). The model could be made more generalisable, and useful to the institution, by the incorporation of additional interpretive case studies of innovative research. While published evidence from other institutions could be examined, there would be a particular benefit to filling in the data within the same institution by:

- identifying local innovators, initiatives and innovation networks within the institution, for example, through an extensive grounded review of published papers;
- incorporating additional case studies of innovation into this grounded analysis, to extend its representation of different approaches;
- investigating ways in which horizontal interest networks and collaborations can be facilitated, for example, by seconding Central Unit staff into faculties or vice versa; and
- tracking the direct and indirect impacts of identified innovative initiatives, with the aim to better understand longer term and subjective cost/benefit factors to the organisation.

While the role of the teacher-as-innovator is well accepted within traditional academic culture, that of the central-developer-as-innovator appears to fall outside traditional structures. Their potential role in shaping localised innovations needs to be clarified and sanctioned by the institution.

The methodology behind the CDR analysis may be relevant to the broader institutional learning process. Institutions need to develop effective ways of representing the experiences of individuals in a manner that will usefully inform organisational strategies. This study has demonstrated the relevance of grounded analysis and action research methods, which could be further developed and utilised as an evidence base for further research. The research could be expanded by:

- collating further perspectives of managers, innovators and others elicited from reviews of the narrative history;
- encouraging development of narrative histories in other projects; and
- documenting further case studies of collaborative research in order to extend the CDR model.

Finally, from an organisational perspective, this study has demonstrated how the OCCA system itself provides a powerful catalyst for innovation in CFL. Its design volatility provides opportunities for significant educational innovation by teachers and developers. Moreover, diffusion of such innovations is then supported by the system.
In this way, OCCA provides strategic advantages over many other CFL systems, such as commercial learning management systems. Institutions need to appreciate that their choice of centralised CFL systems will impact, not only on educational administrative functions, but also on the climate for future transformation of learning and teaching.

14.5 Relating learning, teaching and organisational management: the contribution of this thesis

In this final section, the thesis outcomes are drawn together in relation to the original mission of the study, which was to “facilitate the transformation of learning and teaching within the University” (Section 2.2). To do this I will return to the relational model for learning, teaching and central support developed in Chapters 5 and 6 (Figure 6.9, p. 79). This model provided a succinct summary of stakeholders within the educational setting, relating the perceptions of students, teachers and developers with the approaches they might adopt. For example, in a given situation, a teacher may perceive a time pressure and consequently choose a teacher-centred, rather than student-centred approach to their teaching (Section 5.4). This in turn shapes individual students’ perceptions of their situation, increasing the likelihood they will adopt a ‘surface’ approach to learning. The relational model was extended to a third level of support roles, such as CFL developers, to provide a more complete representation of the educational community.

In order to relate this model to the thesis outcomes, I have shifted the focus from stakeholder roles and products, towards the critical interfaces that bridge them (Figure 14.2). The educational and management interfaces are brought into the foreground of the organisational structure, as the channels through which individuals relate.

![Figure 14.2 Contributions of this thesis as key interfaces between organisational roles (after Figure 6.9)](image)

The roles themselves are also focused less on specific people, but are loosely identified with the activities of learning, teaching/innovating and management/support, undertaken by individuals at different times.
The importance of individual context reflects constructivist notions that have been associated with ‘authentic’ student learning environments, participatory design approaches and the merging of use and adoption considerations within the design process (Sections 4.4, 5.2.2, 6.4.2, 6.4.4). Depending on the particular situation and background, for example, an academic may well adopt the role of teacher, CFL developer, manager, learner or innovator. The responsibility here is shifting to the individual to locate themselves within the community according to their perceptions of their situation at any given time. While the organisation may espouse roles and activities, individuals will operate to a large degree within their own theories-in-practice (Section 6.3.1). As an innovator, for example, at times I need to stand in the shoes of the teacher, or the student, or manager in order to understand their needs and perceptions of their respective situations (Section 5.4). At other times I will act as a project manager, committee member or learner within professional development situations.

The contribution this thesis makes to the transformation of learning and teaching within the University can now be located within this view of the organisation as a bridging framework, rather than hierarchical structure. The various components in Figure 14.2 can be seen to support critical channels of communication through which individuals in different roles are able to better interpret their situation and the perceptions of others, and to adopt practical approaches to improvement.

**Contribution to the educational interface**

As a system that supports the creation of innovative educational environments, OCCA forms a strategic educational interface between the roles of learning and teaching, which can be customised by the teacher to local discipline requirements (Figure 14.2). It has a unique capacity to transform conceptions of educational roles, activities and communications (Section 9.4).

The OCCA teaching environment has been shown to support teachers with optimised views of student work, feedback and reflections made by students (Section 9.4.2). That is, OCCA implementations have the capacity to promote good teaching by facilitating in teachers an awareness of the diversity of their students, their students’ current learning situations and an ability to continually evaluate their own teaching (Section 4.6.2).

At the same time, an OCCA student environment can promote in students the perception of good teaching, experienced through a learning environment created by their teacher that provides them with rich opportunities for collaborative learning and individualised feedback from the teacher or peers (Section 9.4.1). In addition, students may perceive that this environment can be efficiently adapted in response to their feedback (Sections 4.5.1, 10.3, 13.3.1).

**Contribution to the organisational interface**

From an organisational perspective, outcomes of the second and third goals of the thesis can be related directly to the transformation of the management interface. As such, they form a framework for strategic connections between the teacher, innovators and others in the organisation, such as managers or support staff. This interface supports core processes in a learning organisation (Section 6.5).
Firstly, a series of unique and accessible lenses on innovation have been provided, through which the process of innovation by teachers and developers can be better understood by those in management or support roles. These come in the form of a narrative history of workplace experience, alternative stakeholder perspectives and a Developer-centred Innovation Model (Chapters 11 and 12). The generalised model of Collaborative Developmental Research and the detailed case study of a collaborative curriculum development provide additional guidance (Chapter 13). Such views can support institutional decision-making about research and innovation in CFL that is informed by detailed and longitudinal empirical evidence.

In summary, the OCCA system and research analysis together provide an institutional framework for innovation that can be taken up by management and support staff to foster transformation in learning and teaching. By maintaining OCCA as a central system, the Central Unit (TeLaRS) has empowered innovative teachers to create and control their own optimised learning environments (Sections 10.2, 10.3) and fostered multiple approaches to CFL development across the University (Section 10.4). Moreover, a community of users has been fostered who have been able to exchange innovative new techniques and software components. Further contributions to this framework are provided as documented case studies and documentation (Chapters 9, 10).

14.6 Conclusions

The following conclusions can be drawn from this study.

The Online Courseware Component Architecture (OCCA) was developed as a centralised CFL system supporting learning and teaching at university level. Its evolutionary development over a period of four years reflects the difficulty, and significance, of designing a generic system meeting the common requirements of multiple disciplines and learning contexts. While the basic aims of the product were maintained, its conceptual design underwent a profound shift from a complex high-level teaching engine, to a low level architecture supporting basic online transactions between participants in the learning process. It is through this generic architecture that novel environments for both learning and teaching were conceived and implemented by teachers and developers.

The study has demonstrated how the design volatility of OCCA has fostered diverse interpretations of its functionality and manner of use. As a centrally supported online system, it has provided a framework fostering further educational innovation and the sharing of educational components and techniques. Wider exploitation of these open-ended possibilities, however, will require packaging for use in multiple settings and a rethinking of roles for teachers and individuals in support units.

In parallel with the software production, a grounded analysis of the development experience and an earlier case study has provided a unique picture of the innovation process, spanning a period of great change in educational technology between 1991 and 2000. The analysis primarily reflects a developer’s perspective, expressed through a narrative history and emerging developer-centred innovation model. Alternative perspectives were elicited from stakeholders through reflections on the history, outcomes of a collaborative action research project and a re-interpretation of the innovation model from an organisational perspective.
The evidence in this study provides the basis for further research that should draw in additional case studies and more extensive investigation of organisational factors. While this is a highly contextualised study, the rich representation of detail will enable others to judge its relevance to other times and settings. This study has particular relevance to the local institution as a comprehensive history of workplace effects, educational case studies and system documentation that can inform future policy and practice. It has relevance to the wider community for its research into Computer-Facilitated Learning (CFL), ICT systems design, social aspects of workplace practice, diffusion and adaptation of innovation and organisational policy.

I contended that generic CFL systems research and development should involve innovation in both educational design and organisational adaptability. The study shows how collaborations between a central developer and innovative teachers fostered a product of profoundly different character to earlier versions developed for a local setting. The implication for universities is that innovative designs resulting from traditional independent academic research may simply not possess the qualities necessary to invoke significant adoption in other contexts, even with later packaging and promotion. This study suggests that centrally based developers are well placed to bring generic qualities to educational designs and that this can be achieved by close collaboration with key teachers across discipline areas. Organisational strategies, such as funding and facilitation of small cross-institutional project teams, provided a supportive environment for such innovation.

The common notion of a ‘lone innovator’ may not be an entirely useful label for those engaged in leading edge CFL research. This study has revealed a consistent picture of a developer working, not in isolation, but within an eclectic horizontal network cutting across formal structures, reflecting the specialist nature of the research. It was from this network that close collaborations with innovative teachers were forged. Strategic connections were also actively maintained with colleagues, managers, teachers, an external academic reference group and family members, providing multiple opportunities for discussion, feedback and support. This picture of the innovator did reveal periods of intense programming activity and stress, but this was balanced by intrinsic interest and excitement associated with the process of discovery and community interactions, rather than formal rewards.

If research into generic CFL systems is seen as an important strategy in the transformation of learning and teaching, more complete understanding of the innovation process is required. To this end, the study has provided a model of Collaborative Developmental Research (CDR) as an approach that solves local curriculum requirements while simultaneously addressing generic needs of a centralised system development. This is based on a reinterpretation of the developer-centred model of the workplace experience, turned around to provide a view useful to those outside the process. Although drawn from a single development and with limited organisational data, this picture of the innovation process and its participants, problems and facilitating conditions provides a strategic management instrument that can be improved with further analysis.

The CDR process was characterised by stages of exploration, formalisation, iterative prototyping and packaging, in which the innovator’s network and management provide different forms of support. Management plays a strategic role in fostering and guiding the innovation, particularly at critical turning points, when key decisions must be made about a project’s continuance or packaging for wider uptake. This need may not always be recognised by the innovator or accepted as a sign of a successful innovation outcome. Management at this time may need to carefully guide role changes and ensure that acknowledgement of contribution is made.
The grounded analysis of the development provided an opportunity to examine the relationship between a stated study methodology and what actually occurred in practice. The software development was informed by an action research prototyping inquiry model; however, the complex picture that emerged showed how this was subsumed by other factors within the real life workplace setting. For example, tacit mental models, teaching timetables and organisational funding programs were all shown to have major impacts on research decisions and outcomes. Generalised development models are important for guidance and community discourse, but I contend that a mixed-methods approach is most appropriate to accommodate pragmatic adjustment to research methodology in response to the emerging complexities of a real workplace situation.

From an institutional perspective, routine interpretive research into workplace practice will connect organisational strategies and discipline models with the realities of real life experiences. Multi-disciplinary studies on the scale of this thesis will necessarily be limited in number and consequently serve as important reference points, however, specific interpretive techniques can be incorporated into regular practice. For example, the use of narratives to represent extended organisational history in rich contextual detail has great potential. Such representations are accessible at all levels and have a capacity to evoke a sense of human factors and expose important issues otherwise unacknowledged. The study has shown their potential to initiate discourse and the acknowledgement of the multiple perspectives of innovators, managers, teachers, colleagues and those outside the workplace situation but affected by it.
References


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Appendix 1  Index of terminology

The following index indicates some instances of common terminology used within the thesis.

Bolded entries indicate definitions or more significant entries.

Activity Manager (AM) ...................................................................................................................... 129, 130, 131, 133, 134, 176, 184, 284
bracketed ...................................................................................................................................................... 87, 100, 237, 241
CFL................................................................................................................................................................. 23
CFL Systems Development ............................................................................................................................. 23, 25, 27, 30
Classification Framework ............................................................................................................................. 116, 191, 192, 198, 209, (of workplace experience)
Developer-centred Innovation Model .......................................................................................................... 102, 208, 209, 230, 237, 248
HyperCard ....................................................................................................................................................... 8, 115, 129, 130, 169, 171, 172, 173, 276
ID
  Instructional Design activity in analysis ........................................................................................................ 115, 192, 202
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Pragmatic Educational Requirements Guide ............................................................................................. 57, 58, 59, 111, 141, 142, 143
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ResearchMap ............................................................................................................................................... 106, 118, 119, 120, 290
Shockwave (SW) ........................................................................................................................................ 115, 129, 130, 133, 162, 165, 168, 172, 176, 235, 284, 287
State Description Protocol ............................................................................................................................ 131, 134, 136, 177, 178, 184, 235, 278
T&L(M&ET) .................................................................................................................................................. 6, 7
  funding ...................................................................................................................................................... 6, 7, 147, 161, 181, 183, 185
TeLaRS ....................................................................................................................................................... 8, 23, 100, 161, 162, 164, 165, 181, 182, 184, 185, 248
TutorialEngines (TE) ................................................................................................................................. 129, 131, 283
TutorialTools (TT) ...................................................................................................................................... 7, 8, 17, 23, 106, 129, 130, 131, 132, 133, 170, 188, 234, 275
XML ............................................................................................................................................................. 115, 131, 134, 175, 176, 177, 284
Appendix 2  Ethics documents

The following documents relate to ethics approvals sought from the RMIT Human Research Ethics Committee for the research carried out in this study:

- application for approval of a project involving human subjects;
- details of the proposed project;
- details of subjects;
- project classification and estimation of potential risk to subjects;
- ethical issues;
- informed consent;
- interview/survey/questionnaire questions
- plain language state for participants collaborating in project development;
- prescribed consent form for persons participating in research projects involving interviews; and
- plan language statement for participants reviewing narrative history.
RMIT HUMAN RESEARCH ETHICS COMMITTEE

APPLICATION FOR APPROVAL OF A PROJECT INVOLVING HUMAN SUBJECTS
No handwritten applications can be accepted. This form is available from: http://www.rmit.edu.au/departments/secretariat/hrec.html

Section A: Approvals and Declarations

Project title:
Innovation in University Computer-Facilitated Learning Systems: Product, Workplace Experience and the Organisation

A1. Complete this section if you are undertaking Research for a Degree Awarded by RMIT or another university. (Bachelor/Masters by Coursework/Masters by Research/PhD).

Investigator

Name: Paul Fritze
Student No: 9809810M
Qualifications: BSc (hons), MSc (Melbourne), Grad Dip in Instructional Design & Technology (Deakin)
Department: Faculty of Education, Language and Community Services (RMIT)
Address: 1/5 Spencer St. Hawthorn 3122
Phone: 8344 7757 (bh) 9819 6393
Email: p.fritze@unimelb.edu.au
Degree PhD
(for which research is undertaken)

Supervisor

Name: Assoc Prof Carmel McNaught [also Prof Mary Kalantzis –FELCS]
Qualifications: BSc (hons), DipEd, MEd, PhD [BA(Hons), DipEd, PhD]
Department: Learning Technology Services [FELCS]
Campus: RMIT City Campus; [Bundoora]
Phone: 9925 3543 [9925 7919]
Email: Carmel.mcnaught@rmit.edu.au [mary.kalantzi s@rmit.edu.au]

Section A2

Declaration by the investigator(s):

I have read the current NH&MRC National Statement on Ethical Conduct in Research Involving Humans 1999, and accept responsibility for the conduct of the procedures detailed below in accordance with the principles contained in the Statement and any other condition laid down by the University’s Human Research Ethics Committee.

Name: ___________________________ Date: ___________________________
(Signature of Principal Investigator)

Name: ___________________________ Date: ___________________________
(Signature of other Investigators)

Name: ___________________________ Date: ___________________________
(Signature of supervisor – if applicable)
Section B: Project Particulars

B1. Title of Project:
Innovation in University Computer-Facilitated Learning Systems: Product, Workplace Experience and the Organisation


This research study will investigate generic approaches to online learning and teaching. Its specific objectives are to develop a centralised framework for creating innovative learning and teaching environments that are adaptable and accessible to local teaching requirements.

The research is integral to my work in the TeLaRS (Teaching, Learning and Research Support Department of the Information Division at the University of Melbourne) and addresses critical questions facing universities in the use of technology in teaching and learning in higher education. It strength lies in its breadth of inquiry that balances pedagogical, technical and organisational perspectives on practical action. There are three major, interdependent objectives for the research derived from fundamental questions arising in the workplace:

• to design a generic online learning system;
• to increase understanding of the manner in which technology, pedagogy and the institution influence Computer-Facilitated Learning (CFL) development in the real workplace; and
• to devise a practical workplace model for teachers, educational researchers, programmers and support staff to enhance computer-facilitated learning.

The study leverages from my professional work as a researcher, educational designer and programmer, in the context of curriculum development projects undertaken in collaboration with teachers. To develop a generic online learning system, I have used an action research and rapid software prototyping approach capable of responding to changing understandings. Common pedagogical elements emerging within the projects has shaped the formulation of a software framework of a generic nature. The software therefore encapsulates the educational conceptions underpinning these projects and forms a vehicle for other users to articulate theirs.

In order to explore issues that impact on project developments in the real world, the study will include a grounded analysis of my personal experience over a period of five years between 1996-2000. Output from the analysis will include a personal narrative account of this period representing the real-life complexity of the experience. Properties and dimensions will be extracted from the data and relationships established between these. As a grounded theory, the findings will serve to explain the events and provide a basis of further discussion and guidance. The findings will be compared and contrasted with an analysis of a preceding Computer Aided Learning project between 1992-4.

Ultimately, neither the software design nor the prototypical theory of a development experience will maintain currency in this rapidly progressing environment of higher education and technology. Hence, the final goal of the research is to devise and implement a collaborative model for teachers and developers to maintain a parallel process of implementation and research, so that the software and understanding of pedagogical and workplace issues continue to evolve.

B3. Proposed commencement of project
I had assumed that my study in fact commenced in 1996 when I was enrolled under my supervisor at La Trobe University and first received ethics approval. My understanding was that the project was transferred when my principal supervisor moved to RMIT in 1997. It now appears that, not only had the La Trobe study expired but also my enrolment in the PhD program at RMIT was not fully completed. I had assumed the regular enrolment notices indicated that everything was in hand.

B4. Proposed duration of project; proposed commencement/finish dates.
As a research exercise, I considered the project to have run from late 1996. Most of the program development occurred between 1998-2000. I had anticipated being close to final draft this year, to submit early in 2002

B5. Source of funding (Internal and/or external)
No funding

B6. Project grant title; proposed duration of grant (where applicable)
Section C: Details of Subjects

C1. Number, type, age range, and any special characteristics of subjects
I have not considered the people I collaborated with as normal subjects, rather they are everyday work colleagues, being either academic lecturing staff of Melbourne University or post-graduate students and staff in TeLaRS. All are over 18.

C2. Source of subjects (attach written permission where appropriate)
My understanding in the action research study was that, because it was carried out according to normal work practice, it was unnecessary to seek prior permission. It has been made clear to me at this late stage that informed consent should have been obtained. The Director of TeLaRS has since given consent for me to use primary sources within the department. I will also obtain approval from any stakeholders who could possibly be identified in the research, by giving them the right to review and withdraw specific references. I do not anticipate such problems as the handful of people I worked most closely with have all previously collaborated on published papers within the study. Contact with other staff is largely incidental. Students undertaking courses do not form part of this study, other than through regular evaluation that may have been carried out independently by the teachers in accordance with the relevant ethics requirements. References to such data will be limited to already published work.

C3. Means by which subjects are to be recruited
The colleagues involved in the everyday curriculum projects that underpin the development of the generic software come in the normal context of my work with them as an educational consultant.

C4. Are any of the subjects "vulnerable" or in a dependent relationship with any of the investigators, particularly those involved in recruiting for or conducting the project?
I consider none of my colleagues vulnerable any more than in a normal professional relationship.

Section D: Project Classification and Estimation of Potential Risk to Subjects

D1. Please identify the project classification by assessing the level of risk to subjects
MR/ Level 2

D2. If you believe the project should be classified Category MR or Category NR please explain why you believe there are minimal or no risks to the subjects.
The reporting of the rich experience of the development over four years (plus the retrospective analysis of the previous development) is focused on my own personal experience – the sudden revelations, unexpected outcomes, realisations and influences emerging from the grounded analysis. Where others may be implicated, the normal issue of probity applies, as it would in any academic paper or evaluation study. Where there was any chance of misrepresentation or embarrassment permission would be sought from the individual. The issues in writing up the action research aspect of the project 1996-2000, and the retrospective history from 1992-4, are identical, although in the latter case, no consideration was given at the time to a later analysis. These issues are an everyday aspect of professional practice in evaluation and reporting of curriculum projects.

OR

If you believe the project is classified Category AR please identify all potential risks to subjects associated with the proposed procedures. Please explain how you intend to protect subjects against or minimise these risks.

D3. Please explain how the potential benefits to the subject or contributions to the general body of knowledge outweigh the risks.
The opportunity is here to contribute at a level of rich detail into a personal perspective on a major innovative development over a period of nearly ten years. It would be a unique study that cuts to the heart of major issues that concern innovation in educational technology in higher education. The number of people who I worked particularly closely with are aware of my study and are willing to review parts that concern them given the opportunity to amend or withdraw such representations.

D4. Contingency Planning: First Aid / Debriefing
na
D5. Please complete this checklist and give details of any other ethical issues that may be associated with this project.

<table>
<thead>
<tr>
<th>Yes</th>
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<td>X</td>
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</table>

Where you have ticked ‘YES’ to any of the questions on the checklist, please give details and state what action you intend to take to ensure that no difficulties arise for your subjects.

(b) The data collection process will involve access to regular work-related communications, reports, emails as well as notes I made of meetings, my personal reflective journals. Permission has been given by the Head of Department for me to use these primary resources and where there was any chance of misrepresentation or embarrassment existed, permission will be sought from the individual affected. Relevant case examples will be described in a de-contextualised manner where appropriate.
(p) Colleagues have not been asked to provide any more information than would occur within the regular work situation. It is possible that such normal information may in fact, have a minimum potential to embarrass and the steps outlined previously would provide the opportunity to review such representation.

(r) Potential ethical issues are raised in the bringing together research and practice, which are covered by different ethics requirements – such as notice of informed consent being given by co-workers.

Details [except (a) and (b)] must be included in the Plain Language Statement.
**Section E: Informed Consent**

**E1.** Attach to the application-PLS & Consent Form.
This form seems not relevant given the circumstances of the research outlined above.

**E2.** Dissemination of results
Via thesis publication

**E3.** Participants under 18 years
None

**E4** Persons subject to the Guardianship Act (Vic)
None

**Section F: Confidentiality of Records**

**F1.** Describe the procedures you will adopt to ensure confidentiality.
These are very low risk and everyday data and will be maintained with standard security measures such as a secure office and locked filing cabinet.

**F2.** Who will be responsible for security of confidential data?
Fritze holds the primary resources used in this study, collected as normal operations of TeLaRS, and as personal communications and diaries.

**F3.** How long will data be held?
5 years

**F4.** Who will have access to the data, and for what purpose?
Staff of TeLaRS have normal access to regular working records of the department. No one other than Fritze has access to personal communications and diaries.

**F5.** Does this project involve the use of personal information obtained from a Commonwealth department or agency?
No

**Section G: Other Issues**

**G1.** Do you propose to pay subjects? If so, how much and for what purpose.
No

**G2.** Where will the project be conducted?
The University of Melbourne

**G3.** Is this project being submitted to another Human Research Ethics Committee, or has it been previously submitted to a Human Research Ethics Committee?
The project was originally submitted to the La Trobe Ethics committee in 1997. Ethics approval was given by the University of Melbourne for research into students’ use of elements of software developed in this study was given in 1997.

**G4.** Are there any other issues of relevance?
I am concerned that the formal processes of my study seem to have not been fully completed. I realise this was in part my own fault caused by genuine lack of understanding of the implications of research at the time. The system also seems at fault to some extent in not providing a more visible guidance framework. I have put an extremely large amount of work into this project over many years and hope that the issues can be resolved.
INTERVIEW/SURVEY/QUESTIONNAIRE QUESTIONS

For the purposes of the ethical evaluation of intrusive versus non-intrusive questioning please supply a short list of possible questions and/or topics you will be seeking information about from participants.

Research Projects Involving Interviews, Questionnaires

Participants will be academic teaching staff, IT support, educational designers or programmers who have been working with the OCCA online learning system as part of its development or deployment within courses. The questions are directed at a reflection on their project experience to illicit their thinking about teaching, technologies and the workplace.

Examples of questions that would be asked of participants to the study:

• What were some of the critical incidents that occurred that changed the way you thought about your teaching/use of technology?

• In what way did your conceptions change as a result?

• Can you describe how you think about the structure of the online tools for teaching? Perhaps drawing a concept map would help.

• How has this changed over the time you worked on the project?

• How did the technology improve/hinder your students’ learning experience?

• What were some of the workplace pressures you faced - producing the course materials/teaching to students/developing the software?

• Were you ever excited/frustrated by your involvement with the development? Why?
RMIT University
Faculty of Education, Language and Community Services


Investigator: Mr Paul Fritze  
BSc(hons), MSc, Grad Dip Instructional Design and Technology

This research is being undertaken as part of a PhD Degree:

Supervisor: Assoc Prof Carmel McNaught  
BSc (hons), DipEd, MEd, PhD

The Study

I am undertaking a study that aims to improve understanding and methods of using technologies in teaching. The study will focus on the ongoing development of the OCCA online learning system by TeLaRS and its parallel application in real curriculum projects. In order to uncover practical experiences of users and uncover issues affecting the design and use of such systems, I am seeking the involvement of OCCA users and developers in this study.

Firstly, as part of your regular work using OCCA, as teacher, programmer, educational developer etc., I would ask that you maintain a log of incidents, observations, events that changed your understanding, feelings at different times etc. I realize how much time pressure staff are under, so the extent of your involvement is entirely open, but it could be as little as a few minutes a day. I am also involved with the use of OCCA and am treating myself part of this reflective action process.

The second aspect will involve meeting with me occasionally to exchange ideas and observations. Depending on your time commitment and level of involvement, I would anticipate meeting once for about an hour, or perhaps more often for a briefer time. I will take notes of our discussion and would anticipate you would refer to your own log. One practical aim of these meetings is to inform the ongoing design of the system and support provided by TeLaRS. Another is to identify underlying themes emerging from our collective experience concerning the use of technology in teaching within a real workplace environment.

My analysis will draw on my meeting notes and other working project documentation and communications, should you be agreeable. From these I will develop descriptive categories, e.g. incidents leading to new ideas, examples of frustrations/satisfaction. I will look for relationships between these to form a basic model of working experience, bringing to the surface factors that normally go unacknowledged. This will be written up in a largely descriptive manner, illustrated with appropriate case examples. Of course, some issues in the workplace can be politically sensitive. You should feel under no pressure bring these up. If you feel something is nonetheless important, we could discuss ways of representing this in a sensitive manner. In any case, I will use pseudonyms and altered settings so that you would not be personally identifiable and you will have the opportunity to review a draft and refine the interpretation as appropriate. The research findings will published and may be used in be professional development programs.

Participation in the study is of course voluntary and you may discontinue at any time and request that data gathered is withdrawn, where it possible to do so. Logs you keep are entirely private to you and notes I make in meetings and other documents will be kept under lock and key.

If you have any queries, you may also ask for clarification by my supervisor or myself at any time.

Signed:

----------------------------------Date-----------------  ----------------------------------Date-----------------
Mr Paul Fritze  Assoc Prof Carmel McNaught
Teaching, Learning and Research Support  Learning Technology Services
The University of Melbourne  RMIT University
Phone: (03) 8344 7757  Phone: (03) 9925 3543

Any complaints about your participation in this project may be directed to the Secretary, RMIT Human Research Ethics Committee, University Secretariat, RMIT, GPO Box 2476V, Melbourne, 3001. The telephone number is (03) 9925 1745.
RMIT HUMAN RESEARCH ETHICS COMMITTEE
Prescribed Consent Form For Persons Participating In Research Projects Involving Interviews, Questionnaires or Disclosure of Personal Information

FACULTY OF
DEPARTMENT OF
Name of participant:
Project Title:

Innovation in University Computer-Facilitated Learning Systems:
Product, Workplace Experience and the Organisation

Name(s) of investigators: (1) Mr Paul Fritze Phone: 8344 7757
(2) Prof Carmel McNaught Phone: HK (852) 2609 6028

1. I have received a statement explaining the interview/questionnaire involved in this project.

2. I consent to participate in the above project, the particulars of which - including details of the interviews or questionnaires - have been explained to me.

3. I authorise the investigator or his or her assistant to interview me or administer a questionnaire.

4. I acknowledge that:

(a) Having read Plain Language Statement, I agree to the general purpose, methods and demands of the study.
(b) I have been informed that I am free to withdraw from the project at any time and to withdraw any unprocessed data previously supplied.
(c) The project is for the purpose of research and/or teaching. It may not be of direct benefit to me.
(d) The confidentiality of the information I provide will be safeguarded. However should information of a confidential nature need to be disclosed for moral, clinical or legal reasons, I will be given an opportunity to negotiate the terms of this disclosure.
(e) The security of the research data is assured during and after completion of the study. The data collected during the study may be published, and a report of the project outcomes will be provided to _______________________ (specify as appropriate). Any information which will identify me will not be used.

Participant’s Consent

Name: ___________________________ Date: ________________

(Participant)

Name: ___________________________ Date: ________________

(Witness to signature)

Where participant is under 18 years of age:

I consent to the participation of ___________________________ in the above project.

Signature: (1) ___________________________ Date: ________________

(1) (Signatures of parents or guardians)

Name: ___________________________ Date: ________________

(Witness to signature)

Participants should be given a photocopy of this consent form after it has been signed.

Any complaints about your participation in this project may be directed to the Secretary, RMIT Human Research Ethics Committee, University Secretariat, RMIT, GPO Box 2476V, Melbourne, 3001. The telephone number is (03) 9925 1745.

Investigator: Mr Paul Fritze  
BSc(hons), MSc, Grad Dip Instructional Design and Technology  
This research is being undertaken as part of a PhD Degree  
Supervisor: Assoc Prof Carmel McNaught  
BSc (hons), DipEd, MEd, PhD

The Study
I am undertaking a study that aims to improve understanding and methods of using technologies in teaching. The study focuses on the development of an online learning system by TeLaRS at the University of Melbourne, its application in real curriculum projects and the workplace experience of those involved in the development process. This is an extended study that incorporates two case studies of development, covering a period of nine years between 1991 and 2000. As one component of the study, I have written a narrative history of the personal experience within these case studies, giving my interpretation of workplace events associated with the software production and its implementation.

I am seeking the views of teachers, developers, managers and others who may have had some connection with this story, to provide feedback and alternative perspectives on the representation. The views of others with an interest in the processes of innovative development within a university setting are also sought.

To elicit alternative perspectives and feedback, I would invite you to read the narrative history, which should take about 30 minutes, and if agreeable to you, to later discuss this with me. The interview would be at your convenience and take about 30 minutes or longer if mutually agreeable. The format of the interview would be very open, but I am interested in any issues of representation that you feel should be addressed, what in particular came to mind as you read the story, your perspective on the events and recall of similar but unrelated experiences. I would take notes during the interview, which could be done over the phone if appropriate.

From the interview material, I will refine the history if necessary and analyse the themes emerging from the interviews. These will be organised under broad categories, such as developer, teacher, manager, collaborator, colleague, or external illustrated with comments selected from the interviews. You will be acknowledged by name and position, with brief indication of connection to the study. Of course, some issues may be sensitive and you should feel under no pressure bring these up. You will have the opportunity to review a draft and refine the interpretation. The research findings will be published and may be used in be professional development programs.

Participation in the study is of course voluntary and you may discontinue at any time and request that data gathered is withdrawn, where it is possible to do so. The notes I make will be kept under lock and key.

If you have any queries, you may also ask for clarification by my supervisor or myself at any time.

Signed:

-----------------------------------------Date---------  -----------------------------------------Date---------
Mr Paul Fritze  
Teaching, Learning and Research Support  
The University of Melbourne  
Phone: (03) 8344 7757  
Email: p.fritze@unimelb.edu.au  
Prof Carmel McNaught  
Centre for Learning Enhancement and Research,  
The Chinese University of Hong Kong, Shatin, N.T.  
Phone: (852) 2609 6028  
Email: carmel.mcnaught@cuhk.edu.hk

Any complaints about your participation in this project may be directed to the Secretary, RMIT Human Research Ethics Committee, University Secretariat, RMIT, GPO Box 2476V, Melbourne, 3001. The telephone number is (03) 9925 1745.
Appendix 3  TutorialTools – an interactive tutorial generator

The TutorialTools authoring system was designed to facilitate the production of interactive multimedia tutorial sessions in the School of Chemistry. The program was first used in 1993 and accompanied major revisions to the undergraduate teaching program, with a re-written curriculum, introduction of streaming and cutting of practical laboratory classes by 50% at first year level. These were replaced by ‘workshop tutorials’ consisting of approximately half traditional tutorial and half computer-assisted instruction. The computer sessions were run by a tutor and tightly timetabled, serving 1200 students in three streams, usually working 1, 2 or 3 to a computer. The experience of this program was reported in a number of papers (Fritze, 1992a, 1992b, 1993; Fritze & McNaught, 1994; Grant et al., 1995; McNaught et al., 1995; McTigue, Tregloan, Fritze, McNaught & Hassett, 1995; McTigue, Tregloan, Fritze et al., 1994; McTigue, Tregloan, Fritze, McNaught, Hassett et al., 1995; McTigue, Tregloan, McNaught & Fritze, 1994; McTigue, Tregloan, McNaught, Fritze et al., 1994).

The design of TutorialTools was based on the experiences of earlier prototype programs, with modularised structure and authoring tools designed to enable a focus on educational content, rather than programming or instructional mechanisms (Fritze, 1993). Specifically, it was designed to support:

- a potentially high degree of interactivity using various levels of feedback;
- the use of multimedia resources such as QuickTime, colour and sound;
- involvement of many teaching staff assigned to production of individual workshops;
- the ability to update, export and share material when the need arises; and
- on-going research into computer delivery methods and teaching effectiveness.

Instructional model

TutorialTools uses a tutor-learner model of instruction based on interaction elements (Figure A 3.1) including a question statement, a criterion for assessing a correct response, a hint and explanation of the answer. These form a common basis to every question and are directly linked to the traditional experience of teaching.

![Figure A 3.1 Instructional model of a TutorialTools module](image-url)
Each question also has a specified interaction style that determines how the interaction elements are activated. A particular question could be set to run as an assessment item, with no assistance or feedback provided. Alternatively, when run in ‘tutorial’ mode, it would provide query options and respond to actions of the student. Other interaction styles can be designed for different teaching purposes or student learning styles by specifying sequences of feedback steps and messages given to the student.

Before a question can be committed to the screen, an entry mechanism must be chosen. This could be a check box or text entry item or may involve clicking, dragging or sorting objects (e.g. Figure A 3.2). A sequence of questions, with appropriate interaction styles, defines a particular session. A session would typically be tailored for use in a particular stream of students.

![Figure A 3.2 Example of a TutorialTools 'sort items' question](image)

**User interface**

A single popup ‘Tutor’ menu is used to provide a convenient and easy to learn interface which reflects the interaction style of the question and can readily adapt to student progress (Figure A 3.3, p. 275). Menu items are largely self-explanatory, but also can include icons as visual shortcuts. By using a single button, screen design is uncluttered and keeping the student’s focus on the educational content of the question. Graphic design issues are also greatly simplified.

**Authoring environment**

TutorialTools adds menus to the basic HyperCard application to facilitate card level formatting, use of colour, and to streamline question design. The task of incorporating academic content into the program is facilitated by the adoption of a text-based script to generate, edit, import and export questions. All instructional elements are specified in this manner, whether in the form of text, sound or QuickTime movie. With this approach, teaching skills of any staff member can be tapped and questions constructed and updated independent of the master program. The valuable educational component of the tutorial can be separated from the delivery system. It is
possible to convert a card into a text-based description, edit and then re-compile back to the card. A question can be tested before being incorporated into different sessions.

Figure A 3.3 TutorialTools question screen showing ‘Tutor’ popup menu

Evaluation

The students’ progress can be monitored to assist in administering and revising tutorials. A log of student marks is maintained and a follow-up questionnaire is included in all sessions. From this information, the tutor can tabulate marks and establish areas in need of revision. The validity of questions can also be checked by scanning reports of both correct and incorrect responses.

Refinements to the instructional model have been assisted by additional logs of student actions (Fritze & McNaught, 1994). Vital information can also be obtained from tutors themselves, who must respond directly to problems experienced by the students in the workshop sessions. Tools were also developed to facilitate analysis of data and studies of various aspects of the delivery system (e.g. Grant et al., 1995).
Appendix 4  Technical structure of OCCA

The following sections provide a more detailed overview of the technical aspects of OCCA system. These are primarily aimed at individuals establishing an OCCA site and developing Web pages.

A4.1  Structure of a database record

When a Web page in an OCCA site submits information to the OCCA database via a forms post, a record is created with the key field format shown in Table A 4.1. Some idea of the basic database record structure is useful when constructing pages.

Table A 4.1 Format of an OCCA database record

<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>person_id</td>
<td>ID of individual who saved record (used only for audit purposes)</td>
</tr>
<tr>
<td>subject_code</td>
<td>Identity of course assigned at login.</td>
</tr>
<tr>
<td>date_created</td>
<td>Date and time record was created.</td>
</tr>
<tr>
<td>date_modified</td>
<td>Date and time record was last modified.</td>
</tr>
<tr>
<td>role_id</td>
<td>The assigned 'owner' able to access this record, typically the current user, members of a group, or members of the assigned 'peer' group.</td>
</tr>
<tr>
<td>group_id</td>
<td>Name of record owner group.</td>
</tr>
<tr>
<td>page_id</td>
<td>Index name of record. Typically based on file name of page submitting data with the .html suffix removed.</td>
</tr>
<tr>
<td>state_description</td>
<td>String representing the encoded information from page in ‘State Description Protocol’ format.</td>
</tr>
<tr>
<td>directory</td>
<td>Path name of page from which record has been submitted.</td>
</tr>
<tr>
<td>case_id</td>
<td>Top level directory name.</td>
</tr>
</tbody>
</table>

Most of the fields in Table A 4.1, such as ‘subject_code’, ‘person_id’, ‘date_created’ and ‘date_modified’, are self-explanatory. ‘Page_id’, ‘case_id’ and ‘directory’ provide an address for the record. In most cases, Page_id is simply the file name of the submitting page. Role_id and group_id fields help to define ownership of the record and in most cases, these will refer to the login name (person_id) and group_id of the current user. In some circumstances, these can be manipulated at the time of saving to ‘assign’ the record to another user or to a particular group of users. For example, a record generated by a teacher may be assigned to a particular student, and can therefore be viewed by that student in an appropriately designed page, perhaps as ‘feedback’ from the teacher. If the role_id of a record has been set to ‘group’, it can be viewed and edited by any member of the same group. The use of these field values in ‘embed tags’ to retrieve information is discussed below.

A4.2  Standardised description of work: the State Description Protocol

A key feature of OCCA is the ability to take a ‘snapshot’ of Web pages containing any combination of input elements, or even conforming interactive objects (Fritze et al., 2000, p. 7.9). When a page is submitted, its forms data is converted by the OCCA server into standardised State Description Protocol (SDP) form and stored in the ‘state-description’ field of a database record (Table A 4.1). The State Description (SD) is a text string consisting
of property/value pairs, where a value may be either a string or another list. Brackets ‘{}’ enclose a list of properties, which are generated from the names of the forms elements on the submitting Web page. For example, if the Student Input page in Figure 9.4 (p. 138) has text areas named ‘text’ and ‘comment_to_tutor’ and a popup named ‘confidence’, then the SD value for the page is:

```json
{text:"Canberra – between Sydney and Melbourne in the Australian Capital Territory", confidence:"confident",
  comment_to_tutor:"thanks – I appreciated the last tutorial!"}
```

It is significant that the SDP enables a single database to manage *all* page formats, as well as complex interactive components involving nested object structures (Fritze et al., 2000, p. 7.10). For example, the flow diagram object in Figure A 4.3 would generate an SD containing the locations and attributes of the boxes and arrows created by the student. The format is a common object syntax used in various programming languages such as JavaScript and Director Lingo and can be very easily manipulated in such software.

### A4.3 Embed tags within an html page

The primary way in which information is retrieved from the OCCA database is through ‘embed tags’ added to a Web page. When a page is delivered by the server, such tags are replaced with database information according to the tag attributes. There are a variety of tag types, but the following simple example indicates the most common usage. The following tag used in Figure 9.5 (p. 138), where it has been replaced by the text: ‘Canberra – between Sydney and Melbourne in the Australian Capital Territory’, which was extracted from record generated by the Student Input Page.

```html
<occa_embed type="value" page_id="input_page" ref="text" />
```

This string is simply inserted anywhere into the HTML of the page. Web page editing applications such as Macromedia Dreamweaver have facilities to simplify the handling of such tags. The ‘type’ attribute value above indicates that this is a simple tag returning information from a particular record; the ‘page-id’ value specifies the page identity; and the ‘ref’ value indicates which particular forms element is to be inserted, in this case, the contents of the main question text area named ‘text’.

Additional attributes can vary the tag functionality, for example, to return a certain value if no record exists; insert a heading string; return special values if a particular condition is met; or specify a particular group name. Other types of tag are available that:

- return the current session details, such as current user name, group name, login time etc.;
- return conditional values according to a the value of a saved record element;
- return collated sets of records in SDP format which can be displayed on a page using simple JavaScript functions (see below);
- prevent access to a given page except by members of specified groups;
- specify groups allowed to access the page; and
- enable the user to assume the identity of another user and to view or save records by ‘proxy’.
Inbuilt OCCA administration tools

The only inbuilt ‘tools’ provided by OCCA relate to the administration of users. For example, at login, the user’s password, group membership and access rights are retrieved. These are administered by the pages summarised in Table A 4.2. Typically, teaching staff will be assigned to a group named ‘tutors’. Pages designed for teachers can then be protected by making them accessible only to this group. The administration pages are self-explanatory.

**Table A 4.2 OCCA administration pages**

<table>
<thead>
<tr>
<th>Administration page</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Create and edit users</td>
<td>Register users who will be able to access OCCA pages (Figure A 4.1).</td>
</tr>
<tr>
<td>Create groups and assign tutors</td>
<td>Create new groups and assign a supervisor responsible. Typically, multiple student groups and one called ‘Tutors’ are created.</td>
</tr>
<tr>
<td>Assign groups to ‘case’ directories</td>
<td>Enable access by each group to particular main directories in the site.</td>
</tr>
<tr>
<td>Group membership</td>
<td>Allocate users are to particular groups Figure A 4.2. Teachers are typically assigned to a group named ‘Tutors’ and students to groups of two to five.</td>
</tr>
<tr>
<td>Assign peer groups</td>
<td>If required, assign each group can be assigned a ‘peer group’, with whom records can be shared, e.g. for reviewing the work of the peer group and providing feedback.</td>
</tr>
</tbody>
</table>

![Figure A 4.1](image.png) OCCA user administration form used to create and edit user details
A4.5 Extending Web page functionality with HTML and JavaScript

The OCCA system has, quite deliberately, no pre-defined page or report formats, as these would increase the complexity of the system software, yet never be able to satisfy all the future requirements of users. Customised layouts can be achieved instead by using quite simple HTML or JavaScript on the Web page to display information from the database as required. While the details of software programming are beyond the scope of this document, the following simple examples indicate how this can be achieved.

The first example shows how the source of an image on the page can specified by information saved in a database record. The Student Review page (Figure 9.7, p. 138) contains the following HTML image tag:

```html
<img src='occa_embed type="value" page_id="Feedback" ref="stamp"
no_submission_message="blank" />.gif width="88" height="76">
```

This contains an embed tag (in bold) that retrieves to the value of the ‘stamp’ element of a record saved by the Teachers Feedback (Figure 9.6, p. 138). When the page is delivered by the OCCA server, the embed tag is replaced with value ‘brilliant’, so the image tag refers to the image file ‘brilliant.gif’:

```html
<img src='brilliant.gif' width="88" height="76">
```

If no Teachers Feedback record had been submitted, the ‘no_submission_message’ value of ‘blank’ would result in the image ‘blank.gif’ being displayed.
OCCA record values can also be incorporated directly into JavaScript code to create more elaborate display and formatting capabilities. In the following very simple example, the embed tag (indicated in bold) is checked by the OCCA server and if the value returned is equal to ‘confident’, the message ‘You are confident!’ is inserted in the page (as there is no page_id specified, the current page is referred to).

```html
<script>
    if ( '<occa_embed type="value" ref="confidence" />' == "confident") {
        document.write('You are confident!');
    }
</script>

More sophisticated programming is possible using the JavaScript object handling capacities, for example, to create tables of multiple records as in Figure 9.8 (p. 139).

### A4.6 Interactive simulation and interface objects

While the focus so far has been on simple text transactions, the capacity to support highly interactive objects has remained an option (Fritze et al., 2000, p. 7.9-10). For example, the interactive flow chart in Figure A 4.3 was programmed by staff of the Central Unit to enable students can save and recall process designs in Chemical Engineering.

![Interactive Flow Chart](image)

*Figure A 4.3 An OCCA-compatible interactive flow chart object for chemical engineering*

OCCA compatible interactive objects are programmed to convert their current state into State Description Protocol and use an internet ‘POST’ operation to send this to the database, either automatically or when the user clicks the save button. This information can be retrieved in a similar manner when the student clicks the ‘Recall’ button, causing the flow chart design to be re-assembled. Moreover, it is possible for the teacher to review and respond to the students’ designs (Willis et al., 2001, pp. 158-9).
Appendix 5  Statements of software project goals 1991–2000

The following extracts from published documents summarise my aims at different stages of the software development. It is worth noting that such descriptions evolved continuously and the software names referred to did not necessarily align with the name of the phases identified in the analysis (Section 9.2.1).

**TutorialTools**

“The experience gained in ‘hand-crafting’ several tutorials in the past year made it apparent that this approach could not satisfy longer term teaching requirements. Over the past four months therefore, much in my own time, I have developed a framework and support tools to facilitate rapid generation of elegant & effective interactive tutorial material. This involved a significant effort, not only in programming, but also in the thought behind educational concepts.

Key aspects to the framework are
1. a model of instruction based on fundamental elements of a learning interaction
2. an extendable series of interaction and question styles suitable for a range of learning requirements
3. a text format for generating, editing or transferring questions
4. a logging and reporting system.”

(Report to the Head of Chemistry 26/3/93)

**TutorialEngines**:

“a rich set of potentially engaging learning activities
a modular structure, accommodating alternative approaches to teaching and learning
a range of evaluated examples showing how such technology can been used successfully within courses
a low entry point to adoption
a range of management tools, including high quality feedback in the form of progress reports and mapping of usage patterns
opportunities to share, or further develop, learning and management components across different disciplines
expertise in evaluation and consultative advice available through MEU.”

(TutorialEngines Web Site 4/2/97)

**Learning Engines**

“A pedagogical and developmental model for rich Web-based learning activities…
… In light of the increasing importance of the Web in higher education, the Learning Engines project at the MEU is exploring how Computer Aided Learning techniques used in stand-alone packages can be applied to online delivery. The model concerns three levels – the nature of the learning interactions as experienced by the student, the manner in which lecturers structure and work with resources, and the technical development and programming framework. The basis of the Learning Engines teaching model comes from the TutorialTools software I developed for the School of Chemistry… The move from larger, self-contained packages to collections of smaller, modular objects has impacted greatly on the manner in which projects are negotiated and produced, the way in which lecturers work with the materials, and of course, the experiences of the students. Objects being currently developed in Director Shockwave using an OOP methodology and are supported by a software library of standard functions. Most objects are operated as ‘shells’ that are configured at run time with content stored as separate script files.”

(Learning Engines Web Site 25/4/98)
Activity Manager:

“The central educational requirements are to support:

- intricate learning interactions approaching that of the face-to-face experience
- customable interfaces to discipline knowledge
- responsive feedback in a variety of formats
- strategies for open-ended or subjective knowledge areas

From this comes the basic student experience of a ‘learning activity’ – a structured set of content presentation items, tasks and feedback, crafted to meet particular learning requirements. Such activities will continue to evolve in response to local requirements but must be diffused into use across faculties and departments.

The LE component framework is formed around two main ideas:

- a specification ‘language’ for learning activities – via XML
- a standardised protocol for interface objects and other delivery & administrative tools – via the State Description Protocol

The current implementation of the component framework centres around an activity manager object running within a browser.”

(OCCA Overview Document 16/11/98)

OCCA (client-side) / OCCA

“The component architecture can be viewed from different perspectives.

1. Teaching: OCCA provides a method for academic staff to create interactive and customised online learning activity suited to their local teaching requirements. OCCA supports the creation of novel forms of learning activity such as customised interactive interfaces, techniques for reflective & open-ended questioning or group interaction environments.

2. Technology: OCCA is a specification for a scalable, modular online learning environment. It is implemented as a support framework for Web components devised in Shockwave, Java, JavaScript or simple HTML. XML and ‘State Description’ (SDP) protocols are employed to define dynamic content and ‘snapshots’ of interactive Web pages to be saved, recalled or processed.

3. Organisational: OCCA provides an institutional strategy for adding value to curricula. Supporting infrastructure and collaborations at different levels is necessary if it is to impact across the institution or beyond. ‘Products’, skills and vision for the improvement of educational designs must be accessible to teaching staff.

The longer-term goal of the project is to provide the foundations for a self-supporting institutional and wider community of users, to share educational ideas, evaluated experiences and software components.”

(OCCA Overview Document 24/1/2000)
Appendix 6    A child’s story

The following story was told by my daughter Eleanore in 1991 when she was either 7 or 8. It came to light during the reviews of the narrative history by other stakeholders, including my family. I have included it here for its unique perspective on the ‘extended workplace’, marking the very beginning of the first case study examined in this study. It is worth referring also to the perspectives offered in Section 11.4.4.

Once there was a man who lived in a computer – an Apple Macintosh to be exact. Of course he had not always lived in the computer. At first he only worked with it. But gradually he spent more and more time at the keyboard. Every day he would put on his helmet, rain jacket and gloves, plug his radio into his ears and ride off to the university. At night he would return, tired, but happy to see his family, hear their stories, see their work and kiss them goodnight.

One morning he came home with a strange story. He had been working on a particularly tricky HyperCard stack when to his surprise he found himself right inside the Mac. It was so much easier to talk to Mac and for it to talk to him from the inside that he planned to try it at home. Of course, they didn’t believe him. He was always playing tricks, and saying silly things.

In the evenings he and his wife would sit by the fire, she with her books, he with Mac. They took it in turns to make cups of coffee, cut the fruit and put on their favourite music. One night she asked a question but there was no answer. She glanced up but he was not there. Later he handed her half an orange and she thought she must have been dreaming. She often fell asleep by the fire. But the next night it happened again.

On Saturday afternoon he did not mow the lawn and he wasn’t in the garage. On Sunday morning there were no pancakes and they could not find him to go the museum. But Mac shone from his corner and on the screen they could see the father working. He explained that he had a very important project. It would only be for the rest of the week or so he said. They knew about important work so although they missed him they didn’t complain.

The wife put cups of coffee, chocolate biscuits and supplies of peanut better and sultanas beside the Mac and a hand would appear to take the food and give them a brief wave.

But as the weeks passed they began to worry. They had all seen ‘Space Demons’ and knew what could happen if people became trapped inside machines.

They thought of a plan to lure him from the computer. First they put the peanut butter and sultanas just out of reach so that his whole arm had to come out. Next, an open packet of lemon crisp biscuits on the mantelpiece. His head appeared when he stretched for them. After that they placed his favourite food further and further from Mac – frankfurters and potato salad, sponge cake with cream, runny custard and peaches. The night they put the marzipan by the television he stayed to watch ‘Quantum’ and read
the children a story. He began to emerge at regular intervals for food and company and to give them progress reports on the project. ‘Not long now’ he would say, before returning inside.

One sunny day he looked out from the Mac toward the window. A ride would be nice he thought but I have just one more document to complete. On his birthday the family organised a picnic by the river. When he went to return to the Mac – the screen was blank. There was no electricity! They made toast, ate marshmallows and sang songs. The next morning the power was back on but he said the project could wait while he made the pancakes. It was too sunny not to go for a bike ride and then he had to make the children’s Christmas presents in the garage.

Mac was lonely but he printed out the project anyway. He even finished the last document himself!

Eleanore Fritze, 1991 (transcribed by her mother, Victoria)
Appendix 7  OCCA curriculum projects

The following curriculum projects have involved the use of the OCCA system since 1998. A number of these have extended into use within other subjects, while others were finally implemented with other approaches. They are organised by form of development approach, which was defined as departmental, Central Unit or External developers (Section 10.4.1).

My level of involvement is indicated (*=initial consultation, **=design and prototyping, ***=collaboration). Specialised extensions were additional functionality created on top of the basic Web pages and included interactive Shockwave objects (SW) or JavaScript programming (JS).

Table A 7.1  Breakdown of OCCA curriculum projects since 1998

<table>
<thead>
<tr>
<th>Project</th>
<th>Faculty area</th>
<th>Year</th>
<th>Basic educational strategy</th>
<th>OCCA development approach</th>
<th>Specialised extensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Critical appreciation of scientific information</td>
<td>Physiology</td>
<td>1999</td>
<td>Computer-aided collaborative learning environment.</td>
<td>Departmental***</td>
<td></td>
</tr>
<tr>
<td>Learning key physiological concepts (Group Project)</td>
<td>Physiology</td>
<td>1999</td>
<td>Web-based collaborative learning environment (Section 10.2).</td>
<td>Departmental***</td>
<td>Sorting key concepts function (JS).</td>
</tr>
<tr>
<td>Flexible Learning and Interaction Project (FLIP)</td>
<td>Education</td>
<td>2000</td>
<td>Online individual and group exercises, media. Tutors view work and provide feedback (Section 10.3).</td>
<td>Departmental***</td>
<td>Video.</td>
</tr>
<tr>
<td>Current Ed Fac internal grants</td>
<td>Education</td>
<td>2002</td>
<td>Follow from FLIP and C-TaLP</td>
<td>Departmental</td>
<td></td>
</tr>
<tr>
<td>Interactive Learning Kit (ILK)</td>
<td>Education, Medicine and University of Nottingham</td>
<td>2002</td>
<td>Development of a suite of generic page elements, templates and support resources to support wider uptake of OCCA.</td>
<td>Departmental/ Central Unit***</td>
<td>Documentati on database.</td>
</tr>
<tr>
<td>Physical Development Interactive</td>
<td>Education</td>
<td>2002</td>
<td>Incorporation of interactive graphs and time line into OCCA materials. Teacher can configure questions.</td>
<td>Departmental/ Central Unit</td>
<td>SW graph objects.</td>
</tr>
<tr>
<td>Reusable Education and Learning Templates</td>
<td>Education and Monash University</td>
<td>2003</td>
<td>Development of ‘Modular Learning Activities’ as exemplars for use by mainstream staff (new project grant)</td>
<td>Departmental/ Central Unit*</td>
<td></td>
</tr>
<tr>
<td>Animal nutrition</td>
<td>Agriculture</td>
<td></td>
<td>Problem Based Learning, immediate and tutor feedback, content searching. Tutor monitors progress and provides feedback.</td>
<td>Central Unit</td>
<td>Spreadsheets.</td>
</tr>
<tr>
<td>Aural studies</td>
<td>Music</td>
<td></td>
<td>Self-testing audio exercises in musicianship.</td>
<td>Central Unit</td>
<td>SW audio objects.</td>
</tr>
<tr>
<td>Essay proposal submission</td>
<td>History</td>
<td></td>
<td>Essay proposal and references submitted with tutors providing rapid online feedback, annotations and mark (Fritze et al., 2000).</td>
<td>Central Unit**</td>
<td>OCCA/ Quokka.</td>
</tr>
<tr>
<td>Project</td>
<td>Faculty area</td>
<td>Year</td>
<td>Basic educational strategy</td>
<td>OCCA development approach</td>
<td>Specialised extensions</td>
</tr>
<tr>
<td>----------------------------------------------</td>
<td>-------------------------------</td>
<td>-------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------</td>
<td>----------------------------------------------------</td>
</tr>
<tr>
<td>Water &amp; Land Management</td>
<td>Agriculture</td>
<td></td>
<td>Problem solving case study scenarios, discussion forum, drawing tool. Tutor moderates, advises, views and assesses work.</td>
<td>Central Unit</td>
<td>SW farm management tools.</td>
</tr>
<tr>
<td>Researching History module</td>
<td>Arts (History)</td>
<td>1998</td>
<td>Online exercises with auto-feedback. Tutors view responses and provide feedback.</td>
<td>Central Unit</td>
<td>Re-written to use Quokka.</td>
</tr>
<tr>
<td>Chemical process analysis</td>
<td>Chemical Engineering</td>
<td>1999</td>
<td>Simulations of chemical engineering plants and mathematical models. Process modelling tool. Tutor authors questions.</td>
<td>Central Unit</td>
<td>SW flow diagram.</td>
</tr>
<tr>
<td>Physiology of Vision</td>
<td>Science (Optometry)</td>
<td>1999</td>
<td></td>
<td>Central Unit</td>
<td></td>
</tr>
<tr>
<td>Virtual Shopping Mall (VSM)</td>
<td>Arts (English/Cultural Studies) collaboration with University of Auckland</td>
<td>1999</td>
<td>Students explore simulated virtual environment with animations and interactive elements. Critical thinking exercises, self-test quiz. Tutor marks short answer activities and tracks student interactions (Wallace et al., 2003).</td>
<td>Central Unit</td>
<td>SW quiz objects, animations, media.</td>
</tr>
<tr>
<td>Architectural history</td>
<td>Architecture</td>
<td>2000</td>
<td>Students submit architectural design, which is reviewed and voted on by peers. Tutor views work, provides moderation, feedback, marking.</td>
<td>Central Unit</td>
<td>SW design tool.</td>
</tr>
<tr>
<td>Neurobiological and psychological function</td>
<td>Psychology</td>
<td>2000</td>
<td>Comprehensive case study diagnosis environment where students take role of neuropsychologist. Tutors view and mark diagnoses and case notes.</td>
<td>Central Unit</td>
<td>SW animations, video and media.</td>
</tr>
<tr>
<td>Virtual vertometer</td>
<td>Science (Optometry)</td>
<td>2000</td>
<td>Optical instrument simulation and preparatory exercises.</td>
<td>Central Unit</td>
<td>SW optical instrument.</td>
</tr>
<tr>
<td>Biology of Cells and Organisms</td>
<td>Biology</td>
<td></td>
<td>Extensive multiple choice questions.</td>
<td>External</td>
<td></td>
</tr>
<tr>
<td>Discrete maths for engineers</td>
<td>Mechanical and Manufacturing Engineering</td>
<td>1999</td>
<td>Interactive practice tool for linear programming models in engineering analysis.</td>
<td>External*</td>
<td>JS mathematical design tool.</td>
</tr>
<tr>
<td>Telecommunications Networks Design (BestNet)</td>
<td>Electrical and Electronic Engineering</td>
<td>1999</td>
<td>Network design simulator and exercises. Tutor reviews student designs, sets up exercises and sends communications.</td>
<td>External*</td>
<td>SW network design tool.</td>
</tr>
</tbody>
</table>
### Appendix 8  Raw research database record structure

The following raw categories (bold) and dimensions emerged during the initial grounded analysis categorisation process and were used to classify each individual database record (see Section 8.4.4). A selection of these dimensions were then grouped and reorganised under new categories of Phase (Ph), Personal Feelings (P), Reflective Practice (R), CFL Development (D), Organisational Action (O) and Community (C). This became the Classification Framework of the workplace experience (Section 12.2.1) underpinning the analysis in Chapter 12.

<table>
<thead>
<tr>
<th>Source: Origin of data</th>
<th>Type: Nature of record</th>
<th>Action: My workplace activity(ies)</th>
<th>Link: Role(s) of individual or group connected with the situation</th>
</tr>
</thead>
<tbody>
<tr>
<td>conversation</td>
<td>marker</td>
<td>collaborate (O)</td>
<td>academic (C)</td>
</tr>
<tr>
<td>database</td>
<td>milestone</td>
<td>committee (O)</td>
<td>colleague (C)</td>
</tr>
<tr>
<td>diary</td>
<td>product</td>
<td>consult (O)</td>
<td>contract (C)</td>
</tr>
<tr>
<td>documentation</td>
<td>reflection</td>
<td>discover (O)</td>
<td>CSHE (C)</td>
</tr>
<tr>
<td>email</td>
<td>snapshot</td>
<td>discuss (O)</td>
<td>edUnit (C)</td>
</tr>
<tr>
<td>journal</td>
<td></td>
<td>document (D)</td>
<td>extAcademic (C)</td>
</tr>
<tr>
<td>paper</td>
<td></td>
<td>evaluate (D)</td>
<td>extCompany (C)</td>
</tr>
<tr>
<td>software</td>
<td></td>
<td>funding (O)</td>
<td>InfoDiv (C)</td>
</tr>
<tr>
<td>Web site</td>
<td></td>
<td>ID (D)implement (D)</td>
<td>localManagement (C)</td>
</tr>
<tr>
<td>Focus: Broad focus of record</td>
<td></td>
<td>investigate (R)</td>
<td>MMunit (C)</td>
</tr>
<tr>
<td>TandL</td>
<td></td>
<td>negotiate (O)</td>
<td>projectTeam (C)</td>
</tr>
<tr>
<td>technology</td>
<td></td>
<td>plan (D)</td>
<td>students (C)</td>
</tr>
<tr>
<td>organisation</td>
<td></td>
<td>present (R)</td>
<td>U21 (C)</td>
</tr>
<tr>
<td>individual</td>
<td></td>
<td>program (D)</td>
<td>UniManagement (C)</td>
</tr>
<tr>
<td>broad</td>
<td></td>
<td>promote (O)</td>
<td>UniFacility (C)</td>
</tr>
<tr>
<td>Phase: Period of particular activity</td>
<td></td>
<td>publish (O)</td>
<td></td>
</tr>
<tr>
<td>CAL (Ph)</td>
<td></td>
<td>reconceptualise (R)</td>
<td></td>
</tr>
<tr>
<td>LE (Ph)</td>
<td></td>
<td>rethink (R)</td>
<td></td>
</tr>
<tr>
<td>ActivityManager (Ph)</td>
<td></td>
<td>reflect (R)</td>
<td></td>
</tr>
<tr>
<td>OCCA (Ph)</td>
<td></td>
<td>self-ed</td>
<td></td>
</tr>
<tr>
<td>OCCA-SS (Ph)</td>
<td></td>
<td>staff_dev</td>
<td></td>
</tr>
<tr>
<td>Restructuring</td>
<td></td>
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Appendix 9  Visual maps of workplace activity

The following visual maps were generated using the ResearchMap program described on p. 118:

- Overview of dimensions.
- Dimensions related to the individual.
- Reconceptualising.
- Organisational dimensions.
- Projects and technology.
- Curriculum involvement.
- Data sources were also provided in Figure 8.8 and Figure 8.9 (pp. 119-120).

I developed this program specifically to assist in the categorisation process by being able to flexibly map different dimensions and key statements against each other in a chronological manner. This was not possible with qualitative software available at the time. By editing the labels across the top of the map, I could arrange and group dimensions to be charted. Textual data could also be written, for example, the title of all ‘milestone’ events forms a consistent index in all maps together with the principal phases. These maps refer to the raw dimensions of the initial analysis (Appendix 8, p. 289), although most relate closely to those later employed in Section 12.2.1.

They are presented here to provide an audit trail of data (Section 7.7); to complement the representations of developer activity described in Chapters 11 and 13; to indicate the scope of the data coverage; and to enable the reader to explore relationships themselves.
### Teaching and Learning

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#### Curriculum involvement

- **09/1991**: Curriculum involvement
- **1992**: Gold dig in December
- **1993**: Zero public opinion at Hala
- **1994**: Consultancy work at Hala
- **1995**: Consultancy work at Hala

---

### Additional Details

- **Project Descriptions**
  - 09/1991: Curriculum involvement project
  - 1992: Gold dig in December project
  - 1993: Zero public opinion at Hala project
  - 1994: Consultancy work at Hala project
  - 1995: Consultancy work at Hala project

---

**Note**: The table above outlines key milestones and related projects from 1991 to 1995 in the context of teaching and learning, focusing on curriculum involvement.
## Appendix 10 Correlations of dimensions

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**Correlation is significant at the 0.05 level (2-tailed).**
*Correlation is significant at the 0.01 level (2-tailed).