

2014

Development of a prototype knowledge-management system for the purpose of improving teacher pedagogy

Jane Comensoli
University of Wollongong

UNIVERSITY OF WOLLONGONG

COPYRIGHT WARNING

You may print or download ONE copy of this document for the purpose of your own research or study. The University does not authorise you to copy, communicate or otherwise make available electronically to any other person any copyright material contained on this site. You are reminded of the following:

Copyright owners are entitled to take legal action against persons who infringe their copyright. A reproduction of material that is protected by copyright may be a copyright infringement. A court may impose penalties and award damages in relation to offences and infringements relating to copyright material. Higher penalties may apply, and higher damages may be awarded, for offences and infringements involving the conversion of material into digital or electronic form.

**UNIVERSITY OF
WOLLONGONG**



School of Education

**Development of a Prototype Knowledge-Management System for the
Purpose of Improving Teacher Pedagogy**

Jane Comensoli

**"This thesis is presented as part of the requirements for the
award of the Doctor of Philosophy
of the
University of Wollongong"**

January 2014

ABSTRACT

This research focused on the development of a web-based knowledge sharing system designed to support teacher professional practice through collaboration and sharing beyond the boundaries of individual schools. Using design-based research, teachers acted as collaborators in this four-part study that: 1) established a need by teachers for such a system; 2) determined the design heuristics that would inform the development of a knowledge management system; and 3) trialled multiple iterations of a knowledge management system. Design criteria developed were based on Nieson's heuristics (1994), as well as other heuristics identified as applicable to web-based knowledge management systems. Results from user feedback were analysed within the framework of the Technology Acceptance Model (Venkatesh, Morris, Davis and Davis, 2003) and indicated that once *ease of use* criteria were satisfied, the *perceptions of usefulness* became a primary determinant for the prediction of use of the system by teachers. Despite criteria for usefulness having been met, teachers did not use the prototype to inform their work or practice. In the final analysis teachers continued to indicate a desire for a system, thus exposing a significant gap between the espoused values in having the system and the actual behaviour of teachers during the trial. This thesis further explored this discrepancy and concluded that antecedents for usefulness, as defined in the Technology Acceptance Model (TAM 2), were not present in the participant schools. Issues such as teacher professional identity, structures and power relationships, lack of collaborative learning and the impact of school culture all worked against the adoption of the prototype. The thesis concludes by exploring some preliminary steps that have been taken to address the antecedent factors. Early indicators suggest that this is impacting positively on teacher willingness to voluntarily engage in on-line knowledge sharing.

ACKNOWLEDGEMENTS

My thanks are extended to the many teachers who contributed to this work and who shared in such an honest manner their experiences within the workplace. I wish to particularly thank my colleague Leah Mireylees who attended and scribed during all of the phase 1 meetings and Sophia Herdina who brought order to these chapters. I thank the members of the various reference groups that were used throughout this research to ensure independence of the research from the role of the researcher, and the groups who variously provided independent and objective thematic analysis and advice on design options.

My special thanks go to my supervisors, Tony Herrington, Narottam Bhindi and Brian Ferry. They encouraged and guided me, pointed me in the right direction, and stopped me heading down rabbit holes. Without their wisdom, this work would not have been possible.

Finally my family, who walked this journey with me. I thank them for their patience, and for their collective critical eye that granted no favour. My returning to study after a long absence was daunting, and their fearless criticism of early drafts served well to sharpen my thoughts and writing.

TABLE OF CONTENTS

ABSTRACT	i
ACKNOWLEDGEMENTS	ii
TABLE OF CONTENTS	iii
LIST OF FIGURES	vi
LIST OF TABLES	vii
1 Development of a Prototype Knowledge Management System WITHIN A SYSTEM OF SCHOOLS.....	9
1.1 Introduction	9
1.2 Purpose of this Study	12
1.3 Theoretical Background	13
1.4 Design-Based Research Approach	14
1.5 Context	16
1.6 Significance of the Study	18
1.7 Organisation of the Study:	18
2 Literature Review	21
2.1 Introduction	21
2.2 Literature Review	25
3 Relevant Theory	41
3.1 Introduction	41
3.2 Knowledge	42
3.3 Knowledge Management	43
3.4 Knowledge Construction.....	44
3.5 Learning Theory	47
3.6 Knowledge-Building Organisation	62
3.7 Conclusion	64
4 Design Research.....	66
4.1 Introduction	66
4.2 What is Design-Based Research?.....	67
4.3 Characteristics of Design-Based Research.....	72
4.3.1 Situated in a real educational context	76
4.3.2 Focused on the design and testing of a significant intervention	77

4.3.3	Mixed methods.....	80
4.3.4	Involving multiple iterations	82
4.3.5	Involving a collaborative partnership between researchers and practitioners.....	83
4.4	Relevance to this Research.....	86
4.5	Conclusion	91
5	Methodology	93
5.1	Introduction	93
5.2	Ethical Issues – Ethics Approval HE08/150 (Appendix H).....	95
5.3	Phase 1: Analysis of Practical Problems by Researcher and Practitioners	95
5.4	Phase 2: Development of Solutions	103
5.5	Phase 3: Design and Evaluation of a Prototype	106
5.6	Phase 4: Documentation and Reflection	118
5.7	Conclusion	118
6	Phase 1 – Analysis of practical problems by Researcher and Practitioners	122
6.1	Statement of Problem.....	123
6.2	Analysis of Problem by Researcher and Practitioners in Collaboration ..	124
6.2.1	Current use of <i>MyClasses</i>	126
6.2.2	Features of <i>MyClasses</i> that impact on teacher use.....	133
6.2.3	Other sites used and accessed by teachers	137
6.2.4	The expressed need of teachers for a knowledge-management system	141
6.2.5	Other matters raised: expert vs peer contribution	146
6.3	Review of Literature to Determine the Significance of the Problem.....	149
6.4	Identification of Practical Problem and Research Questions for Phase 2	151
7	Phase 2 – Development of Solution Informed by Existing Design Principles	153
7.1	Introduction	154
7.2	Theoretical Framework	155
7.2.1	Feedback Regarding Each Site	167
7.3	Heuristics of a Knowledge-Management System	184
7.4	Validation of Heuristics Through Literature Review.....	189
7.5	New Heuristics	196
7.6	Conclusion	203
8	Iterative Cycles of Testing and Refinement of Solutions	207

8.1	Introduction	208
8.2	Overview	211
8.3	1 st Iteration	212
8.4	2 nd Design Iteration	227
8.4.1	Trial of the Second Prototype	230
8.5	Results.....	233
9	Reflection to Produce Design Principles.....	253
9.1	Introduction	254
9.2	Summary	254
9.3	Discussion across Themes	257
9.3.1	Teacher professional identity	257
9.3.2	Collaborative learning for teachers	266
9.3.3	Connectivity and learning	270
9.3.4	Espoused and actual values.....	271
9.3.5	Activity theory and the impact of culture	275
9.3.6	Technology acceptance model (TAM) and design heuristics	276
9.3.7	Innovation adoption in organisations	278
9.4	Implications.....	279
	CONCLUSIONS AND RECOMMENDATIONS	293
	REFERENCES.....	298
	APPENDIX A – Phase 1 Questions.....	346
	APPENDIX B – Phase 2 Questions	348
	APPENDIX C – Tasks To Be Completed On Each Site During Phase 2 Evaluation	350
	APPENDIX D – Sites Evaluated in Phase 2.....	351
	APPENDIX E – Activities During the 2-week trial of the first prototype.....	352
	APPENDIX F – Participant Survey – First Iteration	354
	APPENDIX G – Page Contents EDUBLOGS.....	360
	APPENDIX H – Ethical Issues – Ethics Approval HE08/150	363

LIST OF FIGURES

Figure 1: Design-Based Research Approach (Reeves 2006)	16
Figure 2: Diagrammatic Representation of the Dissertation.....	20
Figure 3: Engestrom's Expanded Activity Theory Model (Engestrom, 2001).....	60
Figure 4: is a diagrammatic representation of the approach that is taken in this study. From Siemens (2006).....	62
Figure 5: Design-Based Research Approach (Reeves, 2006, p59)	88
Figure 6: Steps in Design-Based Research (based on Ma and Harmon, 2009, 77) ...	90
Figure 7: Development Approaches to IT Research	94
Figure 8: Conceptual Research Model (Davis, Bagozzi & Warshaw, 1989, 985)...	113
Figure 9: Steps in Design-Based Research (based on Ma and Harmon, 2009, 77) .	121
Figure 10: Design-Based Research Phases adopted from Ma & Harmon, 2009: Phase 1 Steps Described	122
Figure 11: Design Research Phases adopted from Ma & Harmon, 2009: Phase 2 Steps Described	153
Figure 12: Technology Acceptance Model (TAM)	156
Figure 13: Design Research Phases adopted from Ma & Harmon, 2009: Phase 3 Steps Described	207
Figure 14: Design Research Phases adopted from Ma & Harmon, 2009: Phase 4 Steps Described	253
Figure 15: Adaptation of Theoretical Model by Jacobson (www.akf.dk/psm_en/papers/c_jacobsen_projdesc_01.pdf , 15)	262
Figure 16: The Cultural Paradigm of Schools Participating in the Trial	274

LIST OF TABLES

Table 1: Relationship Between Learning Theory and the Epistemology of Knowledge	54
Table 2: Theoretical Frameworks Applied in On-line Learning Environments	57
Table 3: Comparison of Design-Based Research Characteristics.....	75
Table 4: Overview of Methodology by Phases	92
Table 5: List of Schools showing School Size, Participant Numbers and Code, and School Distance from Nearest Catholic Systemic School	100
Table 6: Interview Questions and the Construct from Which They are Derived.....	116
Table 7: Focus Group Participants Phase 1.....	125
Table 8: Features Identified as Important through Focus Groups and Comparison against Web Evaluation Criteria	141
Table 9: User Group Demographics	157
Table 10: Demonstration of the Way in which Web Site Purpose Influences the Applicable Heuristics	163
Table 11: Analysis of Sites in Relation to Niesen (1994) Design Heuristics and Identification of Additional Heuristics Required for an On-line Knowledge Management System	188
Table 12: Heuristics for a Knowledge-Management System	205
Table 13: Preliminary Design Heuristic for an On-line Knowledge-Management System.....	211
Table 14: Survey Results Prototype Introduction (n=17)	216
Table 15: Survey Results Trial Period (n=17)	217
Table 16: Comparison of Prototype to Other Tools in Use (n=17)	218
Table 17: Heuristic Evaluation of the First Prototype	223
Table 18: Determinants of Perceived Usefulness. Adapted from Venkatesh & Bala 2008, p277.....	226
Table 19: Summary of Results against Antecedents to Perceived Usefulness	246
Table 20: Motivation for Knowledge-Sharing in Virtual Communities of Practice (VCoPs). Modified from Ardichvilli, A, (2008:54).	249
Table 21: The Three Levels of Culture (Schein, 2010: 24) as observed though the trial	273

Table 22: The External Adaptation Factors for Culture (Schein, 2010: 74).....	284
Table 23: Design Principles for the Development of a Culture for Knowledge- Management.....	288
Table 24: Design Principles for Development of Rules and Structures that Support Knowledge-Management in Schools	289
Table 25: Design Principles for the Development of an On-line Knowledge- Management System	291

1 DEVELOPMENT OF A PROTOTYPE KNOWLEDGE-MANAGEMENT SYSTEM FOR THE PURPOSE OF IMPROVING TEACHER PEDAGOGY

1.1 Introduction

Davenport and Prusak (2000) define knowledge as a mix of experiences, values, contextual information and expert insight that can be used to frame and evaluate new experiences and information. With the increasing availability of technology, and the proliferation of the Internet, knowledge has become the principal and defining asset of an organisation providing both a source of value and competitive advantage (Alavi & Leidner, 2001). Accordingly, the management of knowledge – its creation, manipulation and application, is critical to individual and organisational learning.

Knowledge management is an inter-disciplinary field focused on the nature of knowledge, theories of learning and collaborative knowledge building, and design processes. Although there has been substantive research in the area (e.g. Senge, 1990; Nonaka, 1994; Quinn, 1992; Wigg, 1993; Hasan, Vererikina & Gould, 2003; Maier & Remmus, 2003; Mextaxiotis & Psarras, 2003), numerous definitions of knowledge management exist. For example, Davenport, DeLong, & Beers (1998) and Rosenberg (2006) describe knowledge management as a process of creating, accumulating, organising and disseminating information, expertise and insight within and across people. Sallis and Jones (2000) meanwhile, describe knowledge management as a systematic method for managing individual, group and organisational knowledge using the appropriate means and technology.

Although slightly different, what these definitions have in common is a focus on knowledge management as a process, rather than on the intentionality of purpose or outcome, that is, individual and organisational learning. Additionally, Ardichvili and Yoon (2010) note that few studies have aligned knowledge management explicitly with organisational learning.

This study investigates the development of a knowledge-management system that enables the sharing of knowledge for the purpose of improving teacher pedagogy.

Teaching is a profession defined by intellectual labour. Teachers are required to apply knowledge from multiple domains. For example, the delivery of learning and teaching may, depending on the context, require knowledge of curriculum and pedagogy; classroom management; strategies for students with English as a Second Language (ESL); and strategies for students with special needs. Teachers, therefore, are inherent “knowledge workers” (see Drucker, 1959) as they use and produce knowledge to generate information and deliver effective learning outcomes for students.

As knowledge workers, teachers can benefit from peer collaboration and sharing of their professional insights through reflective practice. However, the isolation of teachers in their own classroom or within their own school continues to impede the continued development of shared teacher knowledge and practice (Sarason, 1982; Little, 1990; McLaughlin, 1993; Huberman, 1993; Hargreaves, 1994; Rousser, 2009). This means that teachers often see themselves as individually responsible for developing resources and activities, and for critiquing their own pedagogical practice. Accordingly, any “learnings” and resources developed, which

could be used to generate new information and understandings for others, are lost due to a lack of systematic knowledge-management systems and practices.

One strategy to address this problem has been the establishment of on-line Communities of Practice (COPs). These are defined as self-organising groups of individuals who share knowledge and learn from each other (Brown & Dugoid, 2001; Wenger, McDermott & Snyder, 2002). Whilst COPs have experienced some success in enabling shared practice among teachers when incorporating face-to-face meetings of members (Wells & Feun, 2007), there has been limited success when the on-line environment is the only platform for knowledge creation and exchange (Parr & Ward, 2006).

The limited success of on-line COPs in education has been attributed in part to the context of teachers' work, where professional autonomy and high levels of individual judgement work against the de-privatisation of practice (Parr & Ward, 2006). Parr and Ward (2006) studied Farnet, an online system that linked ten schools in New Zealand. They found that only those teachers who had been given the explicit accountability for developing the system were active participants, and that teachers generally failed to contribute any teaching materials.

Successful on-line COPs are further limited by the need for an extrinsic motivation or incentive to participate. Crawford (2001), for example, found that shared participation in a series of leadership workshops was needed to create a sufficient identity and shared purpose to then support an online COP involving head teachers. Even then, only forty per cent of the five thousand participants contributed to the shared facility for conferencing of ideas and expertise, and the repository of materials and resource guides.

The concept of an incentive for participation is a theme that underpins participation in other on-line learning environments including e-learning (Nicol, Littlejohn & Grierson, 2005; Vonderwell & Zachariah, 2005) and case-based instruction (Schrader, Leu, Kinzer, Ataya, Teale, Labbo & Cammack, 2003; Dexter, Riedel, & Scharber, 2011; Goeke, 2008; Pearce, 2002; Hyeonjin & Hannafin, 2008)

However, the development of a robust systemic knowledge management system cannot rely on extrinsic motivation or incentive. It also requires contribution from autonomous and self-motivated individuals who will access, contribute and learn from the collective contributions.

1.2 Purpose of this Study

The aim of this study was to explore web applications to determine their potential for teacher-networking and knowledge-management capability. The challenge of the study was to build an online platform, shaped by and responsive to the emerging needs of teachers for knowledge creation and generation.

To achieve this outcome, it was assumed that teachers engaging in the system would need to:

- be self-motivated and self-directed
- take an active role in the learning process
- make decisions about what they will contribute, what they will access, and what materials meet their objective in accessing the system (McAfee, 2006: 26).

The study was therefore conducted in collaboration with practitioners to design a knowledge management system that would be purposeful in meeting their needs. To inform the design of the system, the following questions were addressed:

1. What are currently the key practices for on-line knowledge management and retrieval, and with what other knowledge management practices do teachers engage?
2. How do different forms of knowledge representation support teacher learning and pedagogical practice?
3. What are the functionalities of the knowledge management system that support teacher learning and pedagogical practice?
4. What are the attributes of a knowledge management system that support organisational or expansive learning?

Design principles were developed that applied to the development of a knowledge management system for teachers.

1.3 Theoretical Background

This study is based on the theoretical assumption that users of the knowledge-management system must have dual roles of participants and knowledge creators/sharers (Wenger, McDermott & Snyder, 2002). The underpinning theory that will be relied upon is the Vygotskian theory of constructivist learning, (Vygotsky, 1978) which postulates the view that knowledge originates in social interactions mediated by tools, and can include tangible items such as computers, as well as intangibles such as mental models and norms of behaviour. The work of Nonaka

(1994) and Nonaka and Konno (1998) describing the conversion of individual to organisational knowledge, is based on the Vygotsky view of learning. This is further described in Chapter 3. Situated learning theory, which views learning as the reciprocated process of transformation of both knowledge and learners in action and through action or activities, is a further development and elaboration of the Vygotsky theory of learning. Communities of Practice (Wenger, 1998) have as the theoretical underpinning the theory of situated learning and, as described above, COPs have informed the thinking and development of knowledge-management systems. Also derived from Vygotsky, Engeström's (1999) Activity Theory is used to describe the interaction of teachers with the knowledge-management system within the context of "the rules of interaction" that define the user's goals, participation and interaction for future direction, (Ardichbili & Yoon, 2010).

This study also applies the theory of connectivism (Downes, 2006; Siemens, 2006). Connectivism draws from the work of Vygotsky and situated learning theory, but extends these theories by incorporating aspects of complexity, systems and network theory. Whilst not accepted as a learning theory in its own right (Verhagen, 2006; Kop & Hill, 2008; Bell, 2012), there has been a general acceptance of connectivism as a useful platform to inform design principles applicable to on-line learning applications (Boitshwareto, 2011). This is further discussed in Chapter 3.

1.4 Design-Based Research Approach

A design-based research approach was used as this enabled the critical collaboration between the researcher and the practitioners to occur. Design research enhances design, research and practice concurrently (Wang & Hannafin, 2005) through its engagement with practitioners in the development of new understandings

of real life problems. The design research approach involves literature review and theory generation, as well as formative evaluation, and applies mixed methods data collection and analysis, (Orrill, Hannafin & Glazer, 2003; Reigeluth & Frick, 1999). Whilst there have been some examples of single iteration design research studies (Ma & Harmon, 2009; Drexler, 2010), the design research method generally involves several iterative cycles of design, development, implementation and analysis, leading to design principles and theories (Wang & Hannafin, 2005).

The decision to use design-based research is appropriate for this study given that the problem identified is one of real educational significance, and that collaboration with practitioners is required to develop design intervention. Reeves, Herrington, and Oliver (2005) examined the potential to use design-based research in the higher education setting, and concluded that this methodology is appropriate to examine educational issues given the focus on learning, the need to create a learning environment, the need to recognise the human interactions within learning communities, and the technology required to support these outcomes. Design Research, they conclude, recognises the complexity of these issues, ensures that the technology solution is informed by appropriate theory, allows intensive collaboration over an extended period of time and ensures that design principles are not solely technology-based but reflect the purpose of the research, which is to promote learning.

The Reeves (2006) design research framework was used. This process is depicted in figure 1.

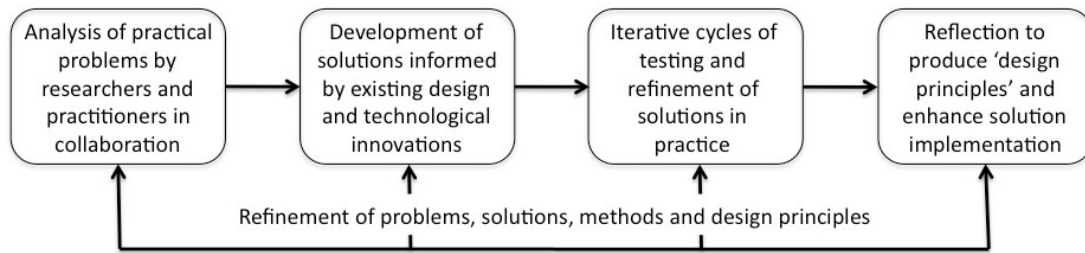


Figure 1: Design-Based Research Approach (Reeves 2006)

1.5 Context

This study focused on designing a knowledge management system that is built with teachers in mind. Collaboration with teachers is therefore an integral part of the design research process. Teachers from within Catholic Education, Diocese of Wollongong and Catholic Education, Archdiocese of Sydney (the CEOs) participated in the study.

Schools within the CEOs are involved in school-identified initiatives to improve pedagogy. Outcomes of such initiatives are shared by teachers at forums and cross-school meetings, but direct sharing of learning is limited due to the geographic isolation of schools, the limited opportunities for whole-school exchanges and the continued pressure from parents not to have teachers absent from classes. These limitations restrict the capacity for organisational learning to occur.

Teachers also have had limited opportunity to engage with colleagues beyond their own school regarding ways to improve individual teacher pedagogy. For example, one of the critical changes to pedagogy that teachers experienced was the introduction of Information and Communication Technology (ICT) into the classroom. To assist teachers, the CEOs introduced a technology platform called

MyClass that provided a virtual learning environment for teachers and students. At the commencement of the study, *MyClass* was primarily used as a tool for individual teachers to engage students through the use of repositories for class materials, discussion forums for students and e-learning folios that allowed student work to be shared. There was limited use of *MyClass* as a platform for teacher sharing either by teachers within a school, or by teachers across several schools. There was no evidence of *MyClass* being used by teachers to share experiences or knowledge gained from school improvement initiatives or to share and reflect on pedagogical practice.

Whilst *MyClass* had limited use beyond the classrooms, there was evidence that some teachers used web sites, blogs, wikis and social bookmarking to enhance teaching practice. This was consistent with the research of Richardson (2008) into the use of web-enabled platforms by teachers. Whilst in theory, Internet applications offered opportunity for teachers to manage, share and apply knowledge, in practice these tools were not combined into a networked learning platform for teachers or a framework for teacher knowledge management and learning in the classroom.

Whilst the focus of this study was on the CEO schools, the literature review (Chapter 2) indicates that the context described is characteristic of education generally. This study therefore has potential for more general application in its focus on understanding of: teachers' knowledge bases and how teachers share knowledge with colleagues; and on the development of a knowledge management system for teachers that allows knowledge to be transferred beyond the boundaries of one school.

1.6 Significance of the Study:

The findings from this research will assist systems interested in the development of effective knowledge-management systems for teachers. This information may also assist in the planning and creation of knowledge-management systems among schools within a system and among schools and other systems where the intention is for teachers to collaborate on the development of new knowledge, as well as engaging colleagues in questions around practice and reflect on the effectiveness of practice for the purpose of engaging self and others in pedagogical improvement.

1.7 Organisation of the Study:

This study is organised into eight chapters that broadly correspond to the four phases in the design-based research process:

Chapter 1 provides an overview of knowledge management and networked learning. It includes an introduction to the study, defines the research problem and purpose, and asks the research questions that inform the design, methodology and significance of the study.

Chapter 2 includes the literature relevant to knowledge management within educational contexts with particular focus on on-line environments. It provides an analysis of elements that may be transferrable from the disciplines of e-learning and communities of practice to inform design principles for a knowledge-management system.

Chapter 3 examines the relevant theory and locates this research in social constructivist learning, informed by principles of connectivism.

Chapter 4 outlines design-based research and its application in the area of education. It provides the basis for use of design-based research methodology in this study.

Chapter 5 outlines the methodology used in this study.

Chapter 6 provides an analysis of the problem as determined in collaboration with practitioners.

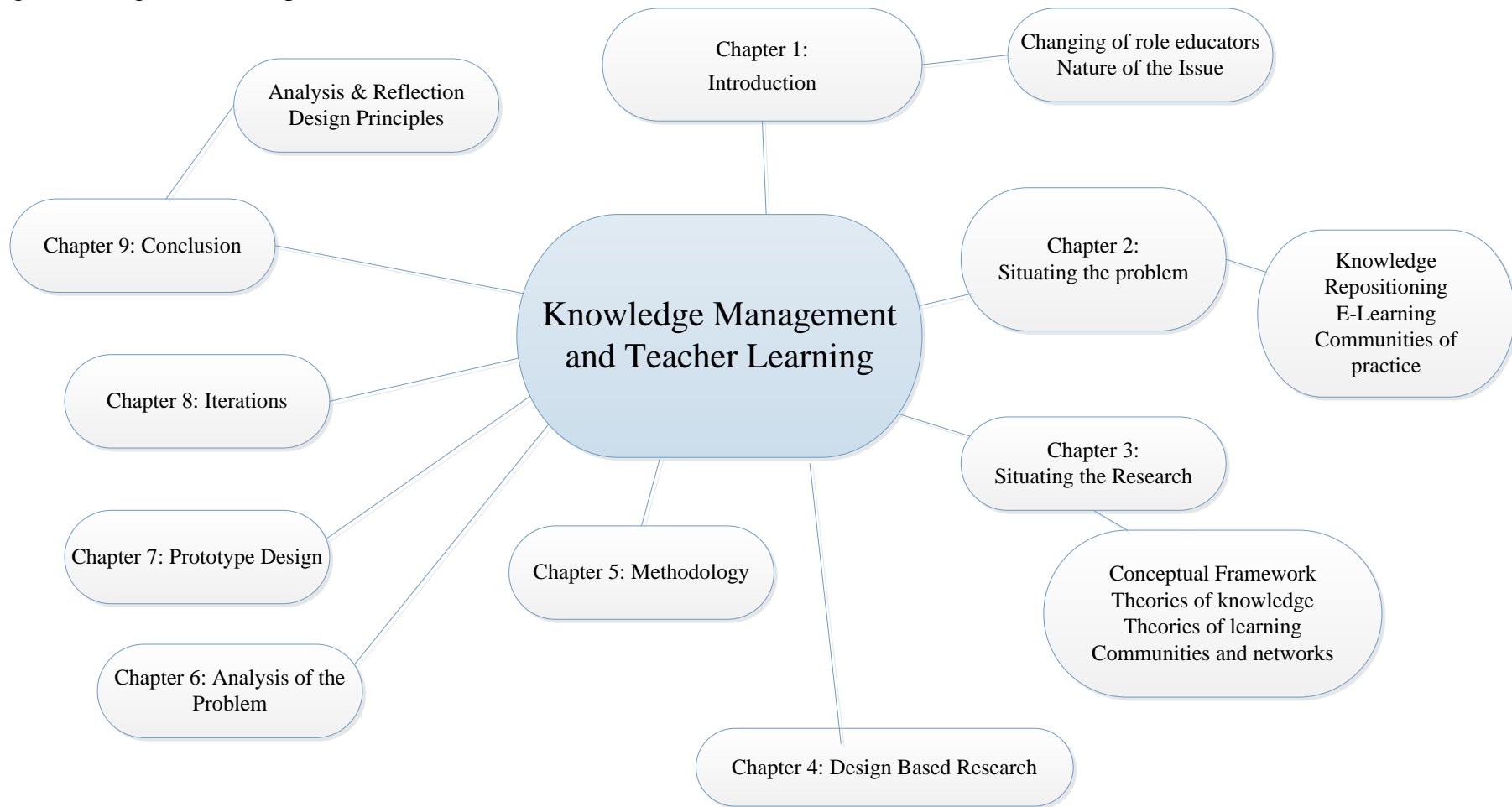
Chapter 7 outlines the development of design principles for the first prototype.

Chapter 8 describes the iterations of the design and the further development of design principles.

Chapter 9 includes a summary of the results, the conclusions and implications relating to future research on knowledge management in the teaching profession.

A diagrammatic representation of the dissertation is detailed in figure 2, below.

Figure 2: Diagrammatic Representation of the Dissertation



2 LITERATURE REVIEW

2.1 Introduction

This chapter reviews the main approaches to knowledge management. It outlines the development of the knowledge management field from a discrete field of study to the current inter-disciplinary approach enabled by the emergence of new platforms that allow knowledge to be developed and distributed through collaborative, autonomous activity within an organisation. The adoption of knowledge management practices within education is studied, with a particular emphasis on the extent to which these approaches have supported teacher learning and professional development, and an examination of the success of other on-line knowledge-sharing and learning approaches.

There are different approaches to the definition of knowledge and these are further defined in chapter 3. However, for the purposes of knowledge management, it is defined as the mix of experience, values, contextual information and expert insight that allows individuals and groups to evaluate and incorporate new experiences and information (Davenport & Prusak, 1998). Knowledge-management systems exist primarily to enable organisational knowledge-sharing.

There is no single definition of knowledge management. Studies have generally defined the term based on the perspective of the research:

- practice and processes, e.g. Bassi (1997) who defines it as the process of creating, capturing and storing information for organisational use;

- the theoretical basis of knowledge transformation and use, e.g. Beijerse (1999) who defines it as assessing experience, knowledge and expertise to create new capabilities and encourage innovation; and
- the technical requirements for knowledge-management systems e.g. Willett & Copeland (1998) who define it as incorporating intelligent searching, categorisation and assessing of data from disparate data bases and files.

Conceptually these definitions have in common the idea of knowledge as something that can reside in individuals, and knowledge management as being the capture and effective utilisation of that knowledge so that it becomes available as an organisational resource. For the purpose of this study, knowledge management is therefore defined as a systematic way to identify, create, represent and distribute knowledge in a way that enables individual and organisational learning and the development of collaborative practices.

In the business environment, knowledge has been positioned as one of the intangible assets of an organisation, enabling data to be assigned meaning and purpose in support of better decision making, improved creativity, and accelerated inventiveness (Spender & Scherer, 2007). Implicit in the positioning of knowledge as an asset, is the assumption that knowledge management benefits an organisation in a variety of ways, such as by accelerating the versatility of organisations to respond to change, supporting individual and organisational learning, and allowing the retention of knowledge beyond what is held by any one individual. The development of knowledge management systems is seen to offer the advantages of time saving, quality improvement, practical knowledge made applicable, replication, consistency,

and the ability to update knowledge, learning tools, cost savings and productivity (Abdullah, Kimble, Benest & Paige, 2006).

In contrast to the business environment, within education there has not been a similar focus on knowledge as a shared asset or on knowledge management. For example, Townley (2003) notes that (higher) education has been slow to implement knowledge management practices. Information that resides with teachers and in the boundaries between levels of schooling, clusters of schools, and the school system as a whole is lost due to the lack of an integrated knowledge management system.

The concept of knowledge management first emerged in the 1990s. Senge (1990) documented early use of corporate repository systems used to support organisational learning. Studies by Sveiby (1996), and Kaplan and Norton (1996), emphasised the potential and the importance of knowledge management as a competitive asset to organisations. However, despite this history, Anand and Singh (2011) position knowledge management as an emerging field. In part, this observation reflects the fact that the focus of knowledge management has undergone several transformations over the past twenty years, driven by changes and advancements in technology, by the tools available to support knowledge management and by the development of new understandings of the way in which knowledge can be used and applied within organisations. These developments have been categorised by Anand and Singh (2011) as representing three generations of knowledge management. The first generation, the period between 1990 and 1996, was made possible by the increased use of technology-enabled storage and representation of information. During this period, knowledge-management research was focused on the design of specific projects that were developed to demonstrate the way in which knowledge

management could be applied in organisational settings (Senge, 1990; Nonaka, 1994, Quinn, 1992; Wigg, 1993). The second generation described by Anand and Singh (2011) occurred in the period of the late 1990s through to around 2002. This period focused on the development of knowledge management in settings beyond project work, demonstrating the organisational value and business development potential from knowledge-management systems (McAdam & Reid, 1997; Alavi & Leidner, 2001; LanSia & Al-Hawamdeh, 2003). The period 2003 to the present has been categorised as the third generation of knowledge management, focused on the social and cultural dimensions of knowledge-creation and application. Accordingly, studies conducted during this period examine aspects of knowledge management such as: the enabling tools (Tyndale, 2002); use of knowledge management to support decision-making (Bolloju et al , 2002); and the application of knowledge management in different settings including higher education (Metaxiotis & Psarras, 2003), and in small-to-medium enterprises (Wong & Aspinall, 2004).

As the field of knowledge management has undergone transformation, there has also been significant change in the tools and methods applied, reflecting the shift **from** a focus on knowledge-organisation and retention, otherwise referred to as the index model **to** a focus on the social network model, (Hansen, Nohria & Tierney, 1999). The index model is based on the concept of the codification of information and knowledge, whilst the social network model focuses on the links between individuals for the exchange of knowledge. The index model for knowledge-management is exemplified by the use of knowledge repositories (Cross & Baird, 2000; Ruggles, 1998), expert directories (Davenport, DeLong & Beers, 1998), and best practice guides (Dixon, 2000). The social network model focuses on more socially-integrated

approaches such as communities of practice (Wenger, McDermott & Snyder, 2002). However, information technology has been the enabler for all of these processes. It has supported the processes of knowledge acquisition, selection, storage, sharing and application and consequently enabled the formation of distributed networks for knowledge transfer and transformation.

2.2 Literature Review

The tools and methods that have been used for the implementation of knowledge-management systems within education have generally followed the pattern of use within business. It is arguable as to whether this mirroring of approach has been due to the natural evolution within the field of knowledge-management or whether it is underpinned by a belief that the educational context requires the same strategies and approaches as the business environment. Whilst the basis of this study is underpinned by a belief that there is both need and opportunity for knowledge-sharing in teaching, and for the support of school initiatives through knowledge-sharing, the literature demonstrates that many of the knowledge-management processes, when applied in an educational context, have failed to deliver the promised benefits. Each of the approaches to knowledge-management within education is now examined:

Knowledge Repositories and Learning Objects

Knowledge repositories are seen as the first generation of knowledge management systems (Huysman, 2005; Garcia, 2006; Schonstrom, 2005; Walsham, 2001). Within education, repositories have been used for the purpose of the re-use and

re-purposing of instructional content (Bennett & McGee, 2005) and for referencing during technology-supported learning (Rehak and Mason, 2003).

Knowledge repositories are comprised of a set of online, searchable learning objects or digital educational resources (Friessson, 2004). The concepts of repository and learning object are closely aligned, with learning objectives being defined as any digital resource that can be re-used to support learning (Wiley, 2002). The promise of learning objects (and repositories) is commonly described as that of “building it once and using it many times” (Goldsmith & Pillai, 2006).

One of the major theoretical objections to learning object repositories has been a criticism that underpinning such an approach to knowledge-sharing is a behaviourist definition of knowledge as an object, external to the learner (Frieson, 2004). This view was challenged by Parrish (2004) who argued that learning objects can be used in the constructivist paradigm when enhanced by the creation of a strategy for adding context when the learning object is integrated or re-used. Research in the area of e-learning has been particularly informative in demonstrating the way in which this can be achieved.

Some literature identifies a connection between e-learning and knowledge-management (Lytras & Pouloudi, 2002a; Lytras & Pouloudi, 2001; Lytras, Pouloudi & Poulymenakou, 2002). Research into e-learning suggests that particular features can be built into knowledge-management systems to create contextual learning and to thereby address the limitations of a repository model. Lytras & Pouloudi (2001) in a case study of three e-learning projects, concluded that flexible learning scenarios, and the ability to dynamically construct the knowledge required is essential. This suggests that if knowledge objects such as lesson plans, instructional guides, and curriculum

guides are included as part of the knowledge-management system in education, they need to be used as more than simple libraries. In order to play a supporting role to active learning, a degree of contextualisation would be required.

Case-based reasoning (CBR) is another approach that has been taken to address the challenge of contextualisation of learning objects. A knowledge-management system built around CBR was Knowledge Innovations for Technology in Education (KITE), designed to assist teachers in the integration of IT into lessons (Means & Wang, 2003; Wang, Means & Wedman, 2003). Designed on the index model, this system de-contextualised and categorised interview data by search criteria or themes that were object-based. Whilst the site was not evaluated as part of the research, the knowledge collection and coding processes used did not follow known research on case-based learning in education as described by researchers such as Schulman (1986) and Ackerman et al. (1996). It is difficult to see how, without specific case format and contextualisation, the site would have had any greater success than previous knowledge repositories developed and used in education.

Studies in education have demonstrated the difficulty of creating effective contextualisation of learning objects, and this has impacted on the effectiveness of repositories as a tool for knowledge management, as they are seen to be irrelevant to the circumstances of the knowledge user (Walsham, 2001; Thomson & Walsham, 2001). Huysman (2005) postulates that one of the key reasons that systems such as libraries of information and data-bases (repositories) fail is that they concentrate on the management of individual knowledge and learning rather than on supporting collective learning.

Koppi et al. (2005) analysed the Learning Resource Catalogue Project (LRCP), a repository set up to support academics within several universities that had formed a consortium called the Universitas 21 (U 21). The intention of the LRCP was to provide an academic network to allow members to identify and share re-usable learning objects and to collaborate in order to minimise replication and re-use unpublished learning and teaching resources. Whilst the intent of such a repository is narrower than what is envisaged in a fully integrated knowledge management system, this study provides useful insights as it examined why the repository did not achieve its intended purpose. These reasons related to: the inclusion of a peer-review system which discouraged users from submitting work; field inputs that were seen as too onerous to complete by individuals; and lack of contribution by teachers who viewed teaching materials as personal and private and requiring protection.

Kato et al. (2003) conducted a pilot evaluation of ICE-Net, a web-based system incorporating a lesson plan and learning material database for teachers. Trialled at three schools, the system revealed that key issues to emerge were similar to those identified by Koppi et al. (2005), and included concerns in regards to privacy protection and resistance to the re-use of another person's work and to having one's own work re-used.

These studies suggest that the issues of ease of use and the self-interest of network members, as well as the unwillingness to share knowledge are likely to be major issues in the design of a knowledge-management system in education. There has been some evidence of knowledge-management systems in business organisations overcoming these issues. In a study conducted by Dyer and Nobeoka (2000) on the knowledge-sharing network at car manufacturer Toyota, the issue of motivation of

members to participate and the discouragement of “free riders” was overcome by the creation of a strong identity within the knowledge-management network, creation of clear rules for participation, and the creation of strong ties to facilitate the transfer of both tacit and explicit knowledge. The Toyota network included both the manufacturer and suppliers, and one of the critical elements for the creation of the shared identity appeared to be the commercial benefit that all parties achieved through the sharing of proprietary knowledge.

The critical question in the application of these studies to the development of a knowledge management system for teachers is whether the creation of a shared sense of purpose is sufficient to overcome the resistance to the re-use of work and de-privatisation of materials of teachers as identified by Koppi et al (2005) and Kato et al (2003). The Nobeoka (2000) study demonstrated that shared purpose can derive from business context. In the educational sector, the focus has been on Communities of Practice (COPs) as a means to create the conditions for shared purpose and knowledge sharing.

Knowledge-Management and Communities of Practice

Due to the limitations of the index model, there has been a shift in knowledge-management from a focus on the technology-driven process of information storage and sharing to a focus on the social network model enabled through technology. Communities of Practice (COPs) has been used as an organising framework within the social network model as it informs: the consideration of broader social factors such as the organisational culture and sense of shared purpose; the value of knowledge within a community; and the practices regarding knowledge sharing, innovation and learning. Lave and Wenger (1991) define a community of practice as

an activity system that includes individuals who are united in action and in the meaning action has for them and the larger community. COPs is characterised as being self-organising and informal. The interaction of COPs members is critical and members learn about professional norms and behaviours through a variety of means such as stories, theories and practices. The outcome of these communication processes is the ability to construct knowledge in a purposive manner (Brown & Duguid, 1991; Wenger, McDermott & Snyder, 2001).

On-line learning and community of practice structures have increasingly been explored together as a means to support socio-cultural approaches to professional learning and support (Conrad, 2008; Maor & Volet, 2007) and knowledge-management. In education, the explicit creation of COPs has been employed to encourage collaborative processes and interactions (Carroll, Chin, Rosson & Neale, 2000; Carroll, Rosson, Dunlap & Isenhour, 2005). Contributors in the area of on-line learning communities include: Garrison (2007); Goodfellow (2005); Palloff and Pratt (2007). In using COPs as the framework for knowledge-management in education, a number of assumptions have been made regarding the ability of educational institutions to meet the characteristics of a COP. As will be evident in the review of the literature, these assumptions have not been supported always by the evidence of research. The characteristics of a COP that support knowledge-sharing are:

1. Members (whether teachers or students) have common work activities and interests. Goffee and Jones (2003) refer to this as “solidarity” with the organisation, created through shared goals and mutual interests. In addition, Goffee and Jones (2003) would argue the need for the existence of individual relationships based upon similar ideas, values, personal

- histories, attitudes and interests, which create sociability and a desire to do things for other members of the community;
2. Members see a collective benefit in the sharing of information; and
 3. Members recognise the need to have access to the expertise of other members.

It is not surprising that the corollary to this has been the identification of three major impediments to successful knowledge-management (Hackett, 2000; Carroll et al., 2003) that counter the COP success factors:

1. Organisations do not clearly articulate the need to manage knowledge;
2. The competing culture of knowledge-hoarding blocks the sharing of knowledge; and
3. Functional barriers within organisations prevent knowledge-sharing.

The impediments to successful knowledge-sharing are driven by culture, politics, values of individuals and organisations, social relationships (Argote, McEvily & Reagans, 2003), and the absence of a clear knowledge-sharing strategy (Child & Shumate, 2007). The degree to which the characteristics of a COP have been implemented to support successful knowledge management systems in education is examined below.

McLaughlin and Talbert (2001) provided one of the first studies examining professional learning communities (knowledge-management sharing and use) in secondary schools. The four-year study involved twelve schools and examined the factors that support teacher success and innovation. The research described how teachers learn to work together and how the type of learning culture of the

community, particularly whether it was strongly traditional or strongly innovative impacted on the type of learning in which teachers were willing to engage.

Wells and Feun (2007) demonstrated the difficulty in establishing the understanding of a collective benefit among teachers sufficient to support the COP and knowledge-sharing, and concluded that the cultural element of teaching is more significant to establishing shared learning than is structure (such as built in time for teachers for the purpose of doing learning community work) or technology. This study examined six secondary schools in which staff had participated in professional development on learning communities, and examined the extent to which the theory was successfully implemented. The study found that despite the fact that teachers indicated that they wanted to collaborate and wanted to engage with colleagues, the implementation of a learning community disrupted the status quo of teaching and pedagogy and caused individual teachers to feel uncomfortable. Limited success was achieved with teachers sharing ideas, concepts and particular lessons. However, in a range of other areas, such as professional dialogue regarding preferred outcomes and results, discussing instructional methods used to teach students, assist failing students or discussing students who fail to learn, there was a much more limited engagement. These latter aspects challenged more deeply-held and personal assumptions of individual teachers. Another critical element of the study appears to have been the lack of ownership by teachers for the success of the learning community with questions such as “collaboration for what reason? What are the expectations? Whose decision was it to establish a learning community?” being expressed by some participants in the study.

Research conducted by Andrews and Delahaye (2000) demonstrated the difficulty in establishing the need among COP members to gain access to the expertise of other members. The study examined the socio/cultural influences present in professional communities of practice that impact on the willingness for professionals to contribute knowledge for collegial sharing. The study took place in a bio-medical consortium that involved five joint-venture partners with 130 scientific staff working on shared projects, and examined the factors that mediated the process of knowledge-contribution and sharing.

It was found that prominent among these factors is the fear that colleagues will evaluate contributions, and this may then become a reflection on the capability, and therefore impact on the career and reputation, of the contributor. Whilst the study was conducted in the arena of scientific collaboration, it is likely that the same professional considerations underpin some of the reluctance among teachers to share with colleagues. The implication for the establishment of a knowledge-management system is that whilst learning can occur through sharing of “errors”, “mistakes” and “failures”, this might not be information that professionals such as teachers are willing to share with others. Hildreth and Kimble (2002) recognise that most organisational knowledge resides within individuals, and therefore an understanding of factors that enhance participation is critical to an understanding of how a knowledge-management system can successfully operate.

The problem regarding willingness/ambivalence of individuals to participate in knowledge-sharing has been examined through a variety of lenses. DeLong and Fahey (2000) describe the importance of creating a culture that encourages positive attitudes to knowledge-sharing. Goffee and Jones (2003) describe the importance of

reciprocal relationships, defined as sociability, between individuals, and solidarity, between individuals and the organisation. Andrews and Delahaye (2000) describe the attributes that support individual knowledge-sharing and propose that within the professional community of scientists, there is a psychosocial filter that mediates the extent to which knowledge-sharing occurs. The filter was found to comprise factors such as individual perceptions of approachability, credibility and trustworthiness. This filter mediates knowledge acquisition processes by deciding from whom knowledge is sought and whose inputs will be accepted. Whilst the study was conducted in a scientific research field, where reputation, career, status, grants and income were consequential to knowledge-sharing it does demonstrate the role individuals play in making choices about whether to share or seek knowledge in a community of practice.

Parr and Ward (2006) examined the formation of an on-line web-based community, FarNet, comprising teachers in ten schools in New Zealand. During the course of the three-year study, researchers: conducted site visits; conducted interviews with teachers who were leaders within an area of FarNet; and surveyed almost 200 teachers regarding the way in which they had used the site, used materials available on the site, and communicated with colleagues. The primary use of the site was found to have been as a repository, a resource collection of documents such as lesson plans, teachers' notes and units. The study found that little material had been contributed by teachers apart from the curriculum leaders and FarNet managers. Parr and Ward (2006) argue that the context of teachers' work, based on professional autonomy and high levels of individual judgement, works against the de-privatisation of practice. This outcome was consistent with outcomes of research on knowledge contribution

and use within professional environments, and particularly within education (Koppi et al., 2005; Kato et al., 2003; Andrews & Delahaye, 2000). Parr and Ward conclude that FarNet was not able to create either a shared need among teachers, or a shared vision for the purpose of contributing. Individual teachers were relatively comfortable with assessing material online to use in their professional work but were not as comfortable with using FarNet as a tool for collaboration with colleagues.

Whereas Andrews and Delahay (2000) postulate for the need for psychosocial filters to be present between individuals who contribute, Parr and Ward (2006) suggest that an on-line community can operate effectively only when cultural preconditions already exist. They conclude, “the notion of collective learning and open consideration of practice should be developed at some level ... before expecting teachers to be willing to share practice with a virtually unknown audience” (Parr & Ward, 2006, 790). The characteristics of the required cultures include openness to improvement (similar to the finding of McLaughlin and Talbert, 2001 and 2006), trust, mutual respect, availability of expertise, and socialisation within the community.

In contrast to the Parr and Ward (2006) study, Crawford (2001) examined the effectiveness of a school leader on-line community that had been effective in supporting collaboration between participants. The invitation to participate was offered to over five thousand participants who had attended a series of residential workshops on school leadership. The site provided four key features designed to support practice when participants returned from the workshop to their individual schools. These were: a conference facility for participants to share ideas and expertise; a good ideas database; a resource guide to support analysis of school

performance data; and selected website links providing an A to Z of sites covering management, education and professional topics. The effectiveness of the site in being able to establish collective benefit to participants was indicated by patterns of use. Most users accessed the site from home, at least weekly, and most valued the conferencing facility in which the ability to share and discuss ideas was noted as the strength of the site. The strongest reason for using the site was stated to be the ability to confer with colleagues on an emotional level, and participate in informed discussion. As there was no specific course content to moderate, participants chose issues. There was a clear role for a facilitator who kept conversations going, brought subjects to a conclusion if interest in a topic was waning and suggested new topics and ideas.

Crawford (2001) attributed the success in establishing a community of practice to the shared identity of participants as head teachers, which created deep connection, shared history, experience, reciprocity and commitment.

The Crawford (2001) study demonstrates that it is possible to develop a COP with many participants within the community, in this instance, over two thousand active contributors. The study does not examine the extent to which the workshop participation contributed to the development of community and shared benefit, and to that extent the study may offer no further insight than Parr and Ward (2006), who postulate that an on-line COP will work only if the cultural pre-cursors have first been established. The study also failed to examine the extent to which, beyond emotional connection, participation in the community provided knowledge to individuals to assist them in their role.

Much of the literature concerning the building of online learning communities refers to situations that relate to research that has taken place in the domain of professional development and the provision of on-line learning programs. However there are significant differences between e-learning and knowledge management systems. In the e-learning environment there is specific course content to be imparted and learning objectives are predetermined. Often in the e-learning environment, there is an incentive to participate in the on-line environment beyond the requirement to gain access to static course material. Examples are the inclusion of projects built on cooperative work structured as part of the program (Nicol, Litteljohn & Grierson, 2005) or assessment marks attached to participation and contribution to on-line discussions (Vonderwell & Zachariah, 2005).

This differs markedly from organisational knowledge management systems in which users do not generally have extrinsic motivational systems to encourage access and participation. Instead, teachers utilising such a system would need to be self-motivated and independent learners.

Knowledge Management and the Web

The concept of on-line community has largely arisen with the advent of the web, and the opportunity for learning communities both to share their work and to extend the notion of community beyond the physical constraints of location. Steeples and Jones (2002) describe the use of ICT in the promotion of learning as based on its ability to promote connections: between one learner and other learners, between learners and tutors, between a learning community and learning resources. Davenport (2008) and McAfee (2006) describe web-2 as the new knowledge-management, enabling knowledge capture and storage, more effective collective intelligence and an

information environment that incorporates both structure and emergence. Prensky (2009) particularly notes that with the “digital natives” entering the teaching workforce, insular models of teacher professional learning no longer capitalise on teacher talents and interests. However whilst many of these new teachers have access to cameras, computers, and video editing, deployment of these tools for professional learning within the community has been limited. Whilst in theory a teacher might videotape a lesson, link student outcome evidence, and upload to a blog seeking the reflections of other teachers on pedagogy, in practice there has been little practical uptake (Lieberman & Mace, 2009).

McAfee (2006) identified the on-line tools used by knowledge workers such as teachers as being either “channels”, defined as emails and person-to-person messaging, or as “platforms” such as intranet, web sites and information portals. Channels do not support knowledge-management, as their visibility is low, given that they are based upon private, person-to-person interactions. Platforms, on the other hand, are widely visible and allow the broader dissemination of knowledge. Lieberman and Mace (2009) identify the Internet as a platform that provides a means to networked learning and the codification of professional knowledge among teachers. In a study of five programs they focused on three key questions: how teachers learn by examining their own practice; what conditions support teacher learning; and how they contribute to reform at local and national level.

For participants in one of the studies, the Carnegie Academy of the Scholarship of Teaching and Learning (CASTL), the sharing of outcomes emerged from the program. Whilst a number of participants wrote for publications and newspapers, the use of multi-media became critical for others to make significant

contribution to the knowledge of their profession. The unanticipated outcome to the project, namely the interest that was generated from the multi-media representations of the scholar's work, demonstrated both the organic nature of learning that is possible using web tools, and the potential for teacher learning that is created when the documentation and representation of teacher practice addresses the "problem of invisibility". Lieberman and Mace (2009) conclude that when teachers go public with their work there is opportunity for them to not only learn about their own practice but also to enlist a group of peers in the work and the generation of knowledge

Conclusion

Knowledge contribution and knowledge use are mediated by more than the technology. In addition to the psychosocial filters postulated by Andrews and Delahaye (2000), other factors have been identified that limit teacher knowledge contribution and sharing. In a knowledge-management system, as opposed to a technology-enhanced learning environment such as e-learning and case-based instruction, on-line participation and collaboration must be voluntary rather than mandated; the online community is expansive rather than limited to course participants and tutors (Mackey & Evans, 2011); learning materials are self-constructed rather than defined by course curriculum to mandate the learning outcomes; and informal learning must be recognised and encouraged. There is little evidence in education of success in creating either the sense of benefit or the need to connect with other expertise that would be fundamental to the creation of a successful on-line knowledge management system.

The conference facility described by Crawford (2001) is one of the few attempts in an educational setting (not linked to specific professional development)

where a community-based discussion has been used to capture insights and experiences of community members. This attempt to accelerate and broaden the knowledge-sharing has indicated promising results despite the limitations in use that were found.

Existing knowledge-management systems developed for education have been based either on the learning object repository model that has proven to have limitations in its application within the culture of education, or on a model of interactive on-line community based on a multi-thread discussion approach utilised in e-learning. The latter approach as adopted in educational settings as opposed to e-learning environments, has failed to integrate learning objects in a meaningful way and failed to engage participants beyond the most recent conversation thread (Hewitt, 2003). Mechanisms to capture and use the wisdom and experience of contributing teachers have not been well developed, nor have systems been designed to record the organisational memory associated with story-telling, problem-solving, solution-generation and decision-making. Research has demonstrated that people will not use knowledge-management systems simply because they exist (Hall, 2006; Parr & Ward, 2006; Santo, 2005).

Lieberman and Mace (2009, p77) describe the challenge of moving teachers from individual practitioner knowledge, described as being detailed, concrete and specific to professional knowledge that can be shared, critiqued and verified (Hiebert, Gallimore & Stigler, 2002). The creation of a knowledge-management system for teachers is required to address the isolation of teachers, enabling colleagues to become a source of knowledge and support, and teachers' public engagement in inquiry regarding their own practice. The system is further required to facilitate

teacher inquiry through on-line networking that allows teachers to submit and analyse resources critically, to access the wisdom of colleagues, to develop materials collaboratively and to participate in reflection regarding pedagogy and classroom practice. It is required to achieve what is described by Ardichvili and Yoon (2010) as the integration of codification, personalisation and collaboration strategies.

3 RELEVANT THEORY

3.1 Introduction

In the previous chapter the link between knowledge, knowledge-management and theories of learning was evident in the analysis of the literature regarding knowledge-management systems in business and education. This chapter further explores each of these theoretical domains, as they are relevant to the area of study.

Evident from the literature, was that knowledge-management has continued to be an emerging field, with a current focus on what has been referred to as the third generation of knowledge-management where knowledge-management is seen as an enabling tool to support decision-making, learning and performance. The challenge of knowledge-management in organisations is to ensure that the organisation continually learns, and that new knowledge is effectively incorporated into practices, so that it is accessible when needed (Carroll, Choo, Dunlop, Isenhour, Kerr, MacClean & Rossan, 2003). Downes (2012) represents the interaction between knowledge, knowledge-management and learning as a cycle: “Knowledge informs learning; what we learn informs community; and the community creates knowledge”.

3.2 Knowledge

In the field of knowledge management, much has been made of the distinction between tacit and explicit knowledge (Lave & Wenger, 1991; Polanyi, 1966; Nonaka & Takeuchi, 1995). Polanyi (1966) described explicit knowledge as knowledge that can be codified in formal systemic language such as organisational policies, procedures and guidelines. He defined tacit knowledge as subjective insights, intuitions and hunches and as “deeply rooted in an individual’s actions and experience as well as ideals, values or emotions he or she embraces” (Polanyi, 1966 as cited in Williams, 2006, 82). Tacit knowledge is characterised by being:

highly personal and hard to formalise ... difficult to communicate and share with others, and it consists of subjective insights, intuitions and hunches; it is deeply rooted in an individual’s actions and experiences as well as in the ideals, values or emotions he or she embraces (Polanyi, 1983 as quoted in Williams, 2006, 82)

The inability of formal knowledge-management systems to effectively capture the tacit dimension of organisation knowledge has led some authors to conclude that “tacit knowledge can (only) be harnessed through sharing activities such as interactive conversations, story-telling, discussions and communication of shared experiences and anecdotes (Polanyi, 1966; Bhardwaj & Monin, 2006; Nonaka & Konno, 1998) or through interactive applications such as discussion forums (Zack, 1999).

Williams (2006) offers an alternative definition of knowledge that is useful for the purposes of this study. Based in the theory of semiotic analysis and with particular reference to the work of Marx (1995) and Prusak et al. (2005), Williams refers to the

process of knowledge-creation as one of moving ante-formal information to formal information and then to knowledge. This theory is better suited to this study since tacit knowledge infers a form of knowledge that is internalised and not necessarily conscious to the holder. Within the tacit/explicit dichotomy, knowledge transfer becomes an issue of “externalising something that you supposedly do not know that you really do know” (Williams, 2006, 85). In contrast, ante-formal information is broader whilst subsuming some essential elements of tacit knowledge, such as the role of intuition and context. Ante-formal information, whilst anecdotal, personal and subjective, is known and shared although not yet formalised (Williams, 2006, 83). Williams (2006, 85) asserts “people decide whether they are willing to formalise their knowledge into a format that allows it to be shared and exchanged.” This assertion applies whether the information is categorised as explicit, such as teaching materials, programs and course notes, or whether it is implicit such as stories and exchanges about decision-making, problem-solving, or teaching strategies, thereby rendering the tacit/explicit distinction insufficient as a basis to model a knowledge-transfer system. Using the Williams (2006) framework, knowledge becomes the “fit” of what works in particular situations, and therefore incorporates both the knowledge-holder and the user as part of the knowledge-transfer system. Citing Saint-Onge and Armstrong (2004, 8), Williams states “knowledge is the capacity to take effective action, in the appropriate context”.

3.3 Knowledge Management

McAdam and McGreedy (1999, 98), building on the work of Demarest (1997) developed a model that identifies four phases of knowledge management in an organisation. They are: knowledge construction, knowledge dissemination,

knowledge use and knowledge embodiment. Lai and Chu (2000) further developed the model and identified seven knowledge-management activities: initiation, generation, modelling, repository/storage, distribution and transfer, use and retrospect. Cook and Brown (1999, 389) differentiate between knowledge, which is something that an individual and group can possess, and “knowing”, which is about the interaction between the knower and the world, that is, use of the knowledge. Notwithstanding the model adopted, the transfer or use of the captured knowledge is fundamental to the success of a knowledge-management system. The design of a successful knowledge-management system must therefore be underpinned by a theory of how people in organisations learn and how they share their knowledge, “so that the organisation as a whole can acquire new knowledge, skills and behaviours among all its staff members” (Bassi, 1997, 29)

3.4 Knowledge Construction

The knowledge-management system must be constructed to enable individual learning to occur, that is learning “oriented towards changes in individual knowledge structures” (Lipponen, Hakkarainen & Paavola, 2004, 35; Bereiter 2002; Popper 1972), and that supports “the capability (of an individual) to use and apply knowledge in new situations” (Lipponen et al. 2004, 33). In transforming ante-formal knowledge of an individual to formal knowledge for the system, there is a risk of de-contextualising the information such that it loses its ability to foster independent thought, action and learning. Williams (2006, 86) describes this as the process of objectification of knowledge, involving subject-stripping and context-stripping. However, knowledge as required for constructivist learning is not “amenable to the processes of subject and context stripping that are the hallmarks of objective

information and it is a fundamental epistemological mistake to think that it is” (p88). Nonaka and Konno (1998, 42) stress the importance of what they call “originating ba” to the concept of knowledge creation. In “originating ba”, individuals share feelings, emotions, experiences and mental models. This issue of context and personalisation is critical to the issue of transitioning teachers from the rudimentary repository style knowledge-management systems described in the previous chapter, to a system that has focus on the social and cultural dimensions of knowledge creation and application. Several approaches to learning through the use of contextualised knowledge have been studied, including narrative and case study.

Narrative as a method of knowledge capture which retains complexity and context, was studied by Brown, Denning, Groh and Prusak (2004); Boje (2001) and Snowden (2002). Reissner (2002) argues that narrative is a key instrument in organisational learning. Lordly (2007, 30) in a study on the use of storytelling as a mechanism to enhance learning states

Storytelling is commonly used within education departments and applied disciplines such as nursing and social work. Benefits include increased understanding of information through personalization, increased critical thinking skills, creation of a context through which meaning and connection are established ... a technique for problem-solving and skill-development

Schulman (1996) examines a particular form of narrative or storytelling, called case study. “Cases” may be specific instances of practice, or exemplars of principles (Schulman 1986, 11). Schulman (1996, 480) states:

Teachers learn quickly that the heart of teaching is developing the capacity to respond to the unpredictable ... cases as the narrative manifestation of chance, offer teachers the opportunities to contemplate the variety of ways in which the unpredictable happens.

If knowledge is narrative then the issue of how to share stories and build collective learning from them is critical. The case study structure argued by Schulman evolves around “a plan that went awry ... some surprise that disrupts the expected scenarios and requires that the teacher re-examine, re-plan or revise the original plan” (p468). However, the research conducted by Andrews and Delahaye (2000), referred to in the previous chapter, raises questions as to whether in a knowledge management system users would be willing to share “plans that went awry” given fear of evaluation by colleague professionals. The four underpinning principles of learning from the case study approach are: learners are active agents in the process, learners can go “meta” and reflect why some outcomes are achieved and others not, learners engage in collaboration to support each other’s learning and learners are scaffolded. Reamy (2002) refers to the importance of having rich and powerful knowledge architecture to capture the potential of storytelling.

Sherif (2006) postulates that the development of software that recognises patterns across scenarios is necessary for organisations to be continuously adaptive and responsive to constant change. This requires new knowledge to be linked to existing knowledge, the abstraction of best practices, feedback and the creation of new knowledge. However, this approach reflects an IT approach to knowledge management, focused on codification and IT infrastructure. The alternative approach would be to take a human focus, which uses IT to support human networks of

knowledge-sharing (Schonstrom 2005). Grounded in social constructivism, individuals across the organisation could be brought together using such IT tools as blogs, mediated discussions, and wikis.

Williams (2006, 91) uses the analogy of the computer game *Myst* to describe the potential of storytelling for individual and organisational learning. The knowledge of how to succeed is based on “the ability to travel through spaces and scenarios, pick up useful ideas and tools to use later, anticipate and avoid certain spaces and encounters ... and put together a multi-tasking set of related strategies within a dynamic context.”

3.5 Learning Theory

Knowledge is intrinsically linked with the social and learning processes. All learning theory is based in epistemology. In thinking about learning, regard must be had to the three major paradigms within the field of psychology that have underpinned learning. The first, developed by Skinner (1953), is behaviourism, which focuses on a link between stimulus and response. Behaviourists focus on observable behaviour (Gredler, 2005, 28) managed through a process of strengthening and weakening of responses. This paradigm has driven models of learning in which the focus is on the teacher instead of the learning, and is based on planned lessons, task analysis and behaviour objectives for learners.

The second, cognitive psychology, focuses on “mental processes that operate on stimuli presented to the perceptual and cognitive systems” (Kirschner, Martens & Strijbos, 2004, 5). Likened to the model of a computer, Driscoll (2000, 75) uses the metaphor of input, encoding, storage and outcome to describe the processes whereby

sensory input is managed in short-term memory, coded and stored, then retrieved from long-term memory. Gagné (1985) postulated that the optimal conditions for learning depend on the goal of the learning process, and the creation of optimal conditions for the learning of each goal. The link between thought and environment (or conditions for learning) is referred to by Brown, Collins and Duguid (1989) as situated cognition and they argue that knowledge is a product of activity, context and culture.

Neither of these paradigms is suited to a knowledge-management system in which the users will be engaged in what Schum (1997) describes as “wicked problems”, issues that require complex judgements, have better or worse solutions (not right or wrong), have no given alternative solutions, and often have moral or professional dimensions. For learning to occur in these domains, the learning environment must support the creation of meaning and sense-making. Mindtools are an example of this approach in the learning environment, and are computer applications that engage the learner in critical thinking about what they are studying (Jonassen, Carr & Yueh, 1998).

Constructivist theory defines learning as a process of active construction as the learner makes sense of their experiences. Learning occurs when knowledge is constructed by the learner, and when learners actively seek meaning and opportunity for knowledge-transfer. The situated nature of learning underpins the work of Lave and Wenger (1991) in *Communities of Practice*. The strength of constructivist learning, particularly in relation to a knowledge-management system, is its focus on understanding, strength, sense-making and meaning.

The growth of Web-2 has allowed individuals to produce information, comment on objects, collaborate on developing objects, publish material, re-use others' materials and gain access to multiple sources of information. The web and other inter-networked technologies have supported and catalysed interest in knowledge creation and sharing. Bell (2011) describes web-enabled learning as learning that is undertaken by individuals as independent, informal learners often within a social setting. Siemens (2006) defines the on-line learning environment as a common in which knowledge flows as people share and refine ideas, and where knowledge is residing in networks of human and non-human appliances, whilst leaving space for human agency.

Ally (2004) analyses the behaviorist, cognitivist, and constructivist schools of thought and finds many overlaps in the ideas and principles when applied to on-line learning. The design of on-line learning materials can include principles from all three schools of thought. Ertmer and Newby (1993) state that the three schools of thought can, in fact, be used as a taxonomy for learning. Behaviourists' strategies can be used to teach the what (facts); cognitive strategies can be used to teach the how (processes and principles); and constructivist strategies can be used to teach the why (higher-level thinking that promotes personal meaning, and situated and contextual learning). Janicki and Liegle (2001) analyzed different instructional design models to identify the components that support quality design of web-based instruction. They identify components from each of the behaviourist, cognitivist, and constructivist schools of learning, and explore connectivist theory (Siemens, 2006) to help designers use it to guide the design of learning materials.

Siemens (2004) argued that behaviourism, cognitivism and constructivism, developed at a time when learning was not impacted by technology, and are no longer adequate theoretical frameworks for describing on-line learning environments. Siemens proposed a new theory of learning called connectivism, which he states is a learning theory better suited to on-line learning, in which information is abundant and diverse, changes constantly, and incorporates multiple perspectives. Connectivism is described by Siemens as an integration of the principles explored in the theories of connective knowledge (Downes, 2006), social constructivism (Vygotsky, 1978) and network theory (Barabasi, 2002). Downes (2006) asserts that knowledge and therefore the learning of knowledge is distributive, consisting of the network of connection, in which technology is part of the distribution of cognition and knowledge. Learning is therefore defined as a process of creating networks of nodes both externally, for access to information and knowledge sources, and internally, the cognition that the learner applies to adopt new information or knowledge. Relying on the work of O'Reilly on the brain and cognitive development, and on Churchland and Sejnowski (1992), Downes (2006) postulates: "The brain as a whole operates more like a social network than a digital computer".

The principles of connectivism defined by Siemens (2006, 31) are as follows:

- Learning and knowledge require diversity of opinions to present the whole;
- Learning is a network formation process of connecting specialised nodes or information sources;
- Knowledge rests in networks;

- Knowledge may reside in non-human appliances and learning is enables/facilitated by technology;
- Capacity to know is more critical than what is currently known;
- Learning and knowing are constant, on-going processes, not end states or products;
- Ability to see connections and patterns and make sense between fields, ideas, and concepts is a core skill for individuals today;
- Currency (accurate, up-to-date information) is the intent of all connectivist learning activities; and
- Decision-making is learning. Choosing what to learn and the meaning of incoming information is seen through the lens of a shifting reality. While there is a right answer now, it may be wrong tomorrow due to alteration in the information climate affecting the decision.

Siemens (2006, 33) argues that one of the strengths of connectivist theory in relation to constructivism is that it deals better with the rapid pace and flow of information by locating some of the processing and interpreting functions of knowledge that flow to nodes within the network.

There is some relevance in the theoretical proposition by Siemens concerning the activity of designing a knowledge management system for teachers. Particularly there is a conceptual fit to the learning ecology required for the development of a knowledge-management system as a self-organised system in which teachers both contribute to and learn from each other, where participation is voluntary and autonomous, and which therefore is characterised by emergence and emergent learning, defined by Williams, Karousou and Mackness (2011) as:

Learning which arises out of the interaction between a number of people and resources in which the learners organise and determine both the process and to some extent the learning destinations, both of which are unpredictable. The interaction is in many senses self-organised

Williams et al. argue that Web 2 has radically transformed knowledge production, communication and dissemination, making emergent learning possible on an unprecedented scale. Collins and Halverson (2010, 19) argue that this places us in an interactive age in which the emphasis is not so much on the transfer of data by individuals and institutions, but rather on interaction and collaboration within social networking. However, Williams et al. caution that this does not necessarily lead to knowledge or emergent learning.

There have been criticisms of connectivism as a theory of learning. Verhagen (2006) argues that as a theory it is unsubstantiated. Kerr (2007) rejects connectivism as a theory, stating that constructivism or active embodied cognition provide sufficient explanation, and that it provides no new principles that are not already present in other learning theories. Verhagen (2006) criticises connectivism as a learning theory, stating it inadequately explains the learning process. Bell (2011), Williams, Karousou and Mackness (2012), and Kop and Hill (2008) have also critiqued connectivism as a theory, stating that connectivism alone is insufficient to inform learning and its support by technology in an internetnetworked world. Kerr (2007) states that connectivism does not adequately explain the transferral-understanding, making-understanding, and building-understanding, that is, the process of learning. Williams et al. (2011) cite the work of Barnes and Tynan (2007) as demonstrating that social networking does not necessarily transfer to learning.

Williams, Karousou and Macness (2012) argue that for learning to occur in a connective environment, there needs to be mechanism for validation and self-correction; for balancing constraints and freedom. Ravenscroft (2011) argues that thinking (learning) in networks requires collaborative dialogue, and that sense-making can occur only through continuous discourses that construct and negotiate meaning.

It is therefore clear that connectivism has not been accepted as a new learning theory, with critics arguing that it does not adequately explain the process by which the learner interacts with information. However, it remains useful as a lens through which on-line learning and knowledge-management systems can be constructed. This view is supported by Kop and Hill (2008), who state that whilst not a theory of learning, connectivism can make a contribution to new paradigms of learning. Siemens and Conole (2012) summarise the current academic thinking and state “connectivism is perceived as relevant by its practitioners but as lacking in rigour by its critics”. Kop and Hill (2008) refer to connectivism as a pedagogical framework, and Boitshwareto (2011) refers to it as an instructional framework, with pedagogical features.

The table below outlines the link between the prominent learning theories and the epistemology of knowledge. It demonstrates the differences between the learning theories discussed above, and the characterisation of connectivism as a theory for distributed learning.

	Objectivism	Pragmatism	Interpretativism	Distributed
Epistemology	Empiricism	Nativism	Rationalism	Complexity
Sources of Knowledge	Experience	Reason and experience	Reason	Networks enhanced by technology
How do we Acquire Knowledge?	Objective, external, sensory experience	Knowledge is interpreted, reality exists, but mediated through symbols and signs	Reality is internal and (like knowledge) is constructed through thought	Knowledge is the pattern of relationships and learning defined as the creation of new connections and patterns
Where does Knowledge Reside?	In the individual – but reflected through external, observable actions	In the individual	In the individual in the context of environments	In internal and external “nodes”- distributive knowledge
Learning Theorists	Skinner, Thorndike, Pavlov, Watson	Vygotsky, Bandura, Bruner, Ausubel, Gagne	Bandura, Piaget, Bruner, Dewey	Siemens, Kerr, Downes, Richardson, Anderson, Cross
Learning Theories	Behaviourism	Cognitivism/ Constructivism	Constructivism	Connectivism

Table 1: Relationship Between Learning Theory and the Epistemology of Knowledge

Notwithstanding the criticism of connectivism as a discrete learning theory, Mackey and Evans (2011) argue that connectivism can provide the design link to pedagogies for on-line learning, and in particular, between social learning theory, formal on-line learning opportunity and authentic learning in community. In designing an on-line knowledge-management system this approach has merit. The design process undertaken in this research considers the theory of connectivism as a pedagogical approach that underpins the design and that incorporates the principles of connectivism, namely:

- *Interaction*
- *Interpretation*
- *Emergence – engagement with other teachers; appropriation of ideas and application into new and different contexts*
- *Physicality*
- *Salience and Inference – selection of salient data and manipulation of bits of information to produce new bits of information*
- *Association*
- *Distribution*
- *Meaning*
- *Shared Meaning network of learners vs COP “which have the potential to be oppressive, exerting pressure towards conformity and crushing individual autonomy (Jones, Ferreday & Hodgson, 2008)*

Based on Downes (2005)

In determining the appropriate theoretical framework for the research, a literature review identified a range of frameworks that are applied to learning in an on-line environment. The table below outlines some of the more recent studies that have been undertaken:

Author	Study/Intervention	Intention/Purpose	Theories
Williams, Karousou & Mackness (2011)	Theoretical framework for understanding emergence	1. Identify conditions that allow self-organised learning to occur and flourish 2. Whether emergent networks can be self-correcting 3. How to link emergent and prescribed learning	Complexity Theory (Snowden & Boone, 2007); Cilliers (2005, 2010)
Mackey & Evans (2011)	Communities of Practice and Professional Learning	Teacher on-line professional learning – university program. Creation of on-line and off-line interactions.	COP social theory of learning - social constructivist learning Connectivism
Kop & Hill (2008)	Review of learning theories with critical analysis of connectivism	e-learning and on-line learning	Constructionism (Papert & Harel, 1991) and Embodied Active Cognition (Clark, 1997)
Boitshwareto (2011)	Development of a research framework for connectivism		Activity Theory (for analysis)

			Communities of Practice (as manifestation of connectivism)
Guder (2010)	Application of learning theory to libraries	How connectivism as a learning theory can assist librarians improve their instruction and interactions with patrons	Connectivism
Dunaway (2011)	How students learn information literacy	Literature review on the design of information literacy instruction	Connectivism and learning networks
Ravenscroft (2011)	Networked social media as a new dialogue landscape	Examine the pivotal role of dialogue interaction in meaning-making and learning within networks	Social constructivism – emphasis on dialogue and discourse

Table 2: Theoretical Frameworks Applied in On-line Learning Environments

In designing an on-line knowledge management system for teachers, there is some resonance to the idea of applying the constructivist theory of learning. As demonstrated in table 2, connectivism has many similarities to socially-constructed learning. Kop and Hill (2008) classify connectivism in its application to on-line learning and web-based activity as an example of socially-constructed learning looking through the connectivist lens. Siemens (2004) refers to the on-line community as a clustering of similar areas of interest that allows for interaction, sharing, dialogue and thinking together.

The study of Mackey and Evans (2011) focused on the learning engagement of teachers who were participating in an on-line professional development program on ICT education. They found that social constructivism theory applied within the network of teachers, and interpreted this as demonstrating that learning can occur despite the absence of strong connections with others. Specifically, secondary teachers adopted practice from their primary co-participants even when they had little in common and demonstrated weak connections. Mackey and Evans (2011) used Community of Practice theory as exemplified in the work of Gravenotter (1983) and Lave and Wenger (1991) and interpreted this observation as an example of weak ties acting as a network bridge enabling new ideas to diffuse between groups. However, looking at the outcome through another theoretical lens, it would also be possible to interpret this as an example where connectivism and the formation of nodes, as opposed to the formation of network or community, created the knowledge that promoted learning among participants. Similarly, participants were found to have brokered information between the on-line community and their teacher colleagues, as evidenced by their willingness within their own schools to lead discussion, support

colleagues and introduce new ideas. Analysed as providing evidence that what was exhibited has some characteristics of a functioning community of practice, the authors also conclude that participants held a nebulous connection ... to the on-line community, but also demonstrated connectivist learning as described by Siemens (2005) and Downes (2006). Participants demonstrated the learning cycle described by Siemens (2008) whereby learners connected to a network to share and find new information, modified their beliefs on the basis of new learning, and then connected to a new network to share these realisations and find new information.

The theory of learning that is applied in this research will be the combination of constructivist learning supported by activity theory (Joanssen & Rohrer-Murphy, 1999; Boitshewarelo, 2011). Activity theory builds on the work of Vygotsky (1978) and conceptualises learning as a system that involves the learner, the object of the activity, and the tools or instruments that are used. In this research, involving teachers across schools, the modified framework below is useful as it introduces the aspect of community to the activity system. It is the community that establishes the rules and customs and beliefs within which the individual (teacher) operates, and there is a possibility that different individuals have different roles with respect to the object (referred to below as “division of labour”). In a knowledge-management system for teachers, the transformation that would be expected is the transformation or change in practice that occurs when the conscious processing of new information interacts with the activity, which in this research is the mental models of the teacher and the physical output of changed pedagogy. In activity theory, the learning and the activity co-exist and are mutually supportive (Jonassen, 2000). Nardi (1996), Kaptelinin (1996), Hewitt (2004), Collis and Margatin (2004), Issroff and Scanlon (2002) have

used Activity Theory as a framework for examining technology-supported learning environments due to the focus on the interdependence of the individual and social and cultural aspects of the environment.

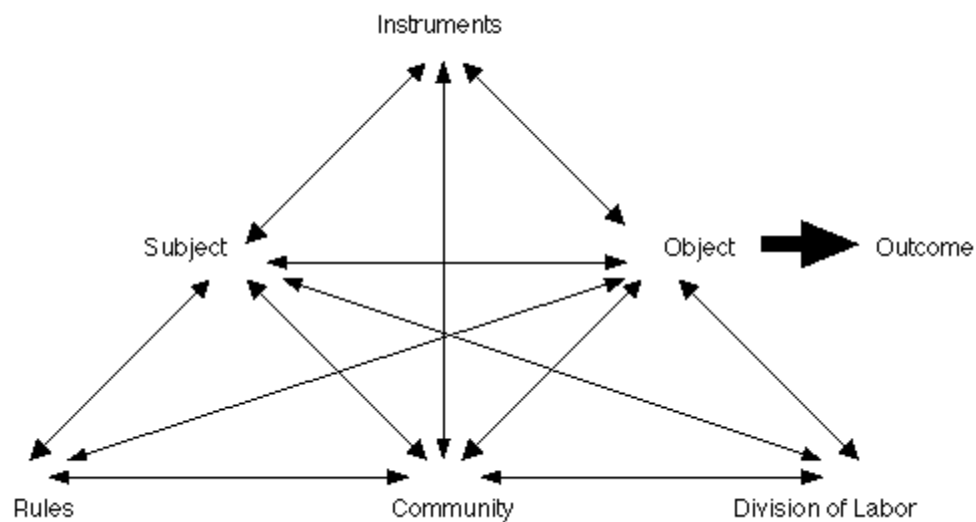


Figure 3: Engeström's Expanded Activity Theory Model (Engeström, 2001)

The principles of connectivism are referred-to as a way of guiding the design principles of the on-line environment. These principles, summarised by Boitshwareto are as follows:

- The central idea of connectivism is that of learners connecting to a learning community and benefitting from it while also feeding it with information;
- The community is viewed as a node that is part of a wider network of nodes. The networks are diverse but connected; support autonomous, diverse and creative knowledge development;
- Knowledge is viewed as not only residing in the mind of an individual, not in one location, but as being distributed across an information network or multiple individuals. Thus, learning and knowledge-creation are

dependent on the diversity of views and opinions and on access to different information streams or hubs;

- Information is constantly changing and there is a need to continually evaluate the validity and accuracy of new information in the light of new knowledge; and
- There is interdisciplinary connection in the knowledge-creation processes, particularly in the internet environment

Boitshwareto (2011) states that “regardless of whether it is a theory or not there is acknowledgement that it is a fresh way of conceptualising learning in the digital age”. The link between activity theory, connectivism and the constructivist theory of learning (as applied in communities of practice), and the research methodology that will be adopted (Design Research), is captured below. It demonstrates the way in which the elements interact, with the design research approach (chapter 4) enabling the users to collaborate with the researcher in developing the on-line tool, which in turn will be used by practitioners and modified based on feedback. The elements of the activity system, its rules and divisions of labour are expected, based on the literature review, to interact with the functioning of the on-line system, and both inform further iterations of the design and impact on the activity system. The way in which these elements interact during the trial of the final prototype is examined in phase 4 of this research.

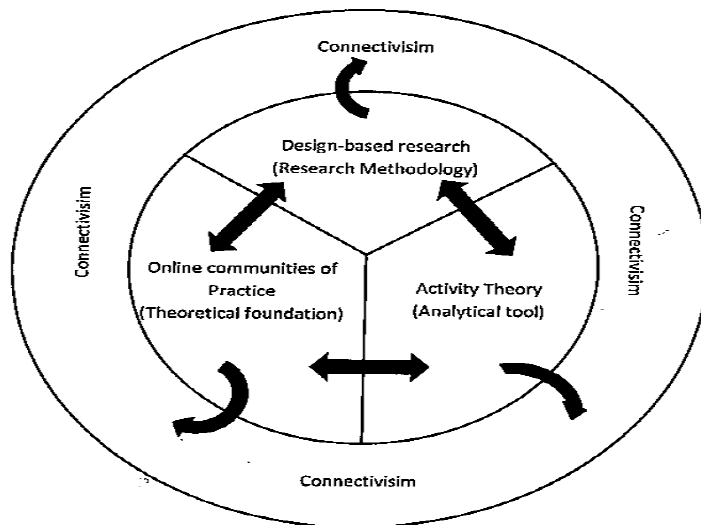


Figure 4: is a diagrammatic representation of the approach that is taken in this study. From Siemens (2006).

3.6 Knowledge Building Organisation

The focus thus far has been on the individual learner and how one might access and use knowledge residing in a knowledge-management system. However, one of the key purposes of creating such a system is to build knowledge for the organisation as a whole. Knowledge-building is used as distinct from organisational learning. The concept of a learning organisation is based on a view that organisations learn only through individuals who are learning – and that through interaction that the learning of one person or group has an effect on another (Garavan, 1997) and (Senge, 1990). The concept of a knowledge-building organisation on the other hand emphasises engagement in collaborative activities, which enable individuals to master something they could not do before the collaboration. In this approach, the role of

mutual engagement and co-construction of knowledge is an outcome of participation in the social process of knowledge construction. Hargraves (2003) states (p109)

One of the most powerful resources that people in almost any organisation have for learning is one another. Knowledge economies depend on collective intelligence and social capital, including ways of sharing and developing knowledge among fellow professionals. Sharing ideas and expertise, providing moral support when dealing with new and difficult challenges ... this is the ... basis of effective professional communities.

Understanding how something new is created within an organisation is critical to a knowledge-management system. Building on the theory of cultural-historical activity theory of Vygotsky (1978) and Leontiev (1981), Engestrom (2001) advances a theory of expansive learning at work. The core of expansive learning “is innovations: situations and action sequences in which actors attempt to go beyond the given, to achieve something that is not yet there, and to master their future” Lipponen et al. (2004, 35). Expansive learning embodies a sequence of activities as follows: 1) questioning of an existing practice, 2) analysing existing practice, 3) collaboratively building new models and concepts, 4) examining and debating created models, 5) implementing the new model, 6) reflecting on and evaluating the process, and 7) consolidating the new practice. The expansive learning model is useful in the field of education as it encompasses polycontextuality and boundary crossing (Engestrom et al., 1995).

3.7 Conclusion

The literature explored multiple epistemological approaches to the nature of knowledge. This study focuses on the research and development of a practical knowledge-management tool for teachers; therefore the focus is on the process of knowledge creation and the application of information technology. The critical elements for this research are:

1. The Nature of Knowledge

Knowledge-management systems must be capable both of capturing the learning of individuals in such a way as to be available to the learning of others, and at the same time capable of supporting organisational knowledge-building. The tacit/explicit dichotomy of knowledge is not useful for the knowledge construction, and instead, the ante-formal/formal distinction proposed by Williams (2005) provides a basis for capturing all types of knowledge. This includes procedural information such as programs and lesson plans which have been objectified, and knowledge that is rich in context and can be captured through narrative and case study. Knowledge as defined for this study is different from, and more than, information and data.

2. The Purpose of Knowledge

Theories of constructivist learning, individual or social, underpin the ability of users to adapt the knowledge to their own requirements and to build new knowledge in the organisation. The process of developing and deploying knowledge is not static, and any knowledge-management system must be capable of changing and responding to new practices. This study therefore requires that the system that is developed is

flexible to the needs of teachers and that knowledge-sharing occurs in ways that support teacher professional learning, practice and decision-making.

3. The Transfer of Knowledge

This study has a focus on the transfer of knowledge through interactions that are not face-to-face. In an on-line environment, the theory of connectivism, whilst not a formal theory of learning, provides some guidance on learning in the digital age and provides a scaffold for connecting individuals to communities to resources through the networking ability of information technology.

In examining each of these elements the collaboration of practitioners is critical in ensuring an effective development process. Design Based Research (DBR) was therefore selected as the research methodology as it enables the design and testing of the transfer medium (the information technology solution) to be conducted within the social context of the teachers, thus incorporating proper consideration of the nature and purpose of the knowledge that teachers require. Design Based Research methodology and its application to this research is further explained in the following chapter.

4 DESIGN RESEARCH

4.1 Introduction

This chapter describes the development of Design-Based Research (DBR), its suitability for research that has multiple social influences, the characteristics of DBR and how this research meets those elements, and the four-phased approach that has been adopted throughout the study in accordance with the model described by Reeves (2006).

Chapter 2 described the approaches that have been taken to on-line knowledge-management in education. It is clear from the studies, that an analysis of knowledge-management requires an examination of socio-cultural factors and a multi-disciplinary approach. The involvement of the user was determined to be critical for this study to overcome the reported limitations of previous studies. During these studies the effectiveness of the developed sites was influenced by: relevance to the users (Walsham, 2001; Thomson & Walsham, 2001); concerns regarding the personal and private nature of work (Koppi, Bogle & Bogle, 2005; Kato, Hatan, Sakamoto, Morimoto, Komika & Matsuda, 2003); usability of the site (Koppi et.al., 2005); the type of learning teachers are willing to engage in (McLaughlin & Talbert, 2001); and the need for contributions to be of a voluntary rather than a prescribed nature (Mackey & Evans, 2011).

The Design-Based Research (DBR) was chosen for the research methodology, as it is characterised by practitioner collaboration throughout the intervention and allows for user-input into the purpose of the site, site-design and design enhancements.

4.2 What is Design-Based Research?

DBR, also referred to as development research, is a research methodology that informs instructional design. It generates solutions to complex, real-world problems, using existing theory and practice. Data are used to evaluate and refine the solution, and during the process new theoretical knowledge is created. Wang & Hannafin (2005) define it :

A systematic but flexible methodology aimed to improve educational practices through iterative analysis, design, development and implementation, based on collaboration among researchers and practitioners in real-world settings and leading to contextually-sensitive design principles and theories” (p6)

Brown (1992) described the emergence of research-design methodology and the tension between the “relative contributions of classroom and laboratory study”. The work of Brown, and others (Bereiter & Scardamalia, 1989; Brown & Campione, 1990; Fish, 1980) were based on studies of student learning and the realisation that rather than having teachers operating as independent contributors to classroom learning, factors such as “teacher training, curriculum selection, testing, and so forth actually form part of a systematic whole” (p143). These early pioneers of DBR acted on the premise that to change one aspect of the system would cause perturbations in others, thus as researchers there was a responsibility with them for “simultaneous changes in the system concerning the role of students, teachers, the type of curriculum, the place of technology and so forth” (p143). Brown (1992) described the

goal of what was referred to as “interventionist research”, as working toward a holistic theoretical model of learning and instruction rooted in a firm empirical base. The early contributors to design research articulated key elements that continue to inform this methodology – the focus on research, design and pedagogical practice. Shavelson, Phillips, Towne and Feur (2003) describe this as follows:

Such research, based strongly on prior research and theory carried out in educational settings, seeks to trace the evolution of learning in complex, messy classrooms and schools, test and build theories of teaching and learning and produce instructional tools that survive the challenges of everyday practice (p25).

Brown’s work was largely informed by learning theories that reflected a swing between behaviourist learning theory and cognitive learning theory and the “awakening ... that real-life learning inevitably takes place in a social context” (Brown, 1992, 144). Thus much of the early design work undertaken by Brown on developmental theory of learning switched back and forth from the laboratory setting to the classroom setting. For example, children’s analogical reasoning and explanation strategies were initially tested under experimental conditions under which variables were controlled (Brown & Kane, 1988) and then researched in classroom settings.

Our routine procedure is to set up controlled laboratory studies to evaluate whether the developmental trend can be reproduced under experimental control (Brown, 1992, 153)

Cobb and DiSessa (2004) describe the importance of what is considered a key criterion for design work “ that theory must do real design work in generating, selecting and validating design alternatives at the level at which they are consequential for learning” (p77), and argue that design experiments have been under-developed as contexts for the development of theory. DBR should aim to generate empirically-grounded theory and generalise design principles during the iterative process (Barab & Squire, 2004; Design-based Research Collective, 2003). Cobb and DiSessa claim that the use of theory in DBR as “ontological innovation” (p78), described as the work of generating categories that do “useful work in generating, selecting among and assessing design alternatives”.

Gravemeijer (1994) argues that the intention of DBR is to ensure that such global basic theory is elaborated and refined in local theories and refers to “a process that is guided by a theory and also produces a theory” (p444). As an example, Gravemeijer (1994) cites the work of Treffers (1987) who developed a theory regarding the characteristics of progressive mathematics, or the theory of quantitative reasoning (Thompson & Thompson, 1996). In addition, situated learning theory (Lave & Wenger, 1988) and activity system theory (Engstrom, 1998, 1999) have, among others, informed DBR (Cobb & DiSessa, 2004, 78).

Bell (2010) identifies a breadth in the theoretical and methodological approaches to DBR, that reflects the complexity of settings, the emergent characteristic of the research, and the variety and complexity of educational settings: “different efforts are focused on developing different kinds of theory, products and strategies for bringing innovation to scale” (p243). Wang and Hannafin (2005) describe DBR as a “systematic but flexible methodology aimed to improve

educational practices through iterative analysis, design development and implementation based on collaboration among researchers and practitioners in real-world settings (p7). Multiple design and research methodologies are a characteristic of design research. In looking for coherence, Bell postulates that design-based research can be viewed as “a high-level methodological orientation that can be employed within and across various theoretical perspectives and research traditions to bring design and research traditions to advance our understanding of learning-related educational phenomena” (p245). Bell identifies four specific families or modes of DBR.

The first mode, based on Brown’s work discussed earlier, is the developmental psychology design-based research. Studies in this area were primarily in the field of psychology, and linked cross-disciplinary studies in the social, psychological and biobehavioural disciplines.

The second mode is cognitive science design-based research. Based on theoretical models on the nature of knowledge, the design research in this area has focused on cognitive processing of knowledge, such as perception, reasoning, meta-cognition, decision-making and problem-solving. Bell cites several examples including the research conducted by White (1993) on the influence of computer simulations on student learning in physics; research by White and Frederiksen (1998) on the impact of self-assessment on metacognitive scaffolding of learning; and Schwarz(1998) on the nature of scientific modelling.

The third mode described by Bell is cultural psychology design-based research. This approach focuses on “a system of knowledge, beliefs, behaviours and customs peculiar to an interacting group” (Fine, 1993, 123). Within this culture the

design research is focused on the interactions among individuals and artefacts. Bell described The Fifth Dimension (Cole, 1996) as an example of this type of study, which focused on learning activities in after-school club contexts. These “communities are less focused on specific shared educational outcomes, but rather they involve design based efforts to promote sustainability and generative learning activities that are compelling to participants” Bell (2010, 248).

Design experiments involving educational activity are complexly constructed social systems in which it is simply not possible to be sure at all times what combination of factors is at work to produce the phenotypical appearances. All such systems are emergent products not only of factors identified as internal to the system, but factors that involve the necessary openness of such systems to the social systems to which they are embedded (Cole 2001, 8)

Finally, Bell refers to mode four as linguistic or cognitive anthropology design-based research, in which the meaning of an intervention is explored from the point of view of the participants of the research as interpreted through their activity and accounts. Examples of this approach cited by Bell include the work of Barab et al. (2001); Polman (2000) and Stevens (2000).

Whilst Bell’s analysis is useful in describing the breadth of DBR applications, the characterisation of such studies within defined categories does not fully describe the theoretical underpinnings required in complex studies, in which the research may be context-based and the distinction between categories blurred owing to the need to integrate a variety of approaches. Bell acknowledges this when describing cognitive

science design-based research, and the need to couple design research to theory regarding the application of principles to local context and impact on cognition.

This study is about the development of an on-line management system for teachers and, similarly, does not fit uniquely into one of the four areas characterised by Bell. In part, the study is in the domain of cultural psychology, as it examines the interactions among teachers in developing and maintaining an on-line learning community. Whilst the intent of the research is to promote, through design, a sustainable and generative site that promotes teacher-sharing and collaboration, the study needed to also draw on cognitive science to inform decisions regarding style and content that will have the intended outcome of assisting teacher decision-making and problem-solving.

4.3 Characteristics of Design-Based Research

Anderson and Shattuck (2012) reviewed DBR studies that covered the period 2002 to 2012. Of the forty-seven scholarly articles examined, two distinct types were identified; 34% were expository and 66% provided empirical evidence and results of studies. They describe DBR as an emerging research framework, noting that 74% of the empirical studies had occurred between 2007 and 2011. Oh and Reeves (2010) also assert that DBR is an emerging research paradigm, referring to it as “relatively novel”. Within the studies reviewed by Anderson and Shattuck (2012), four key areas emerged as areas of research: potential for student learning; new understandings about educational outcomes or context; increased student learning; and improvements in attitude/epistemology/motivation (Anderson & Shattuck, 2012, 22). Further classification of the research indicated that 87% of studies were directed to student

learning, 68% involved on-line and mobile technology and all were part of multi-iteration research projects.

The combined focus on theory-building and practical application distinguishes design-based research methodology from other research methods. “Design based research is premised on the notion that we can learn important things about the nature and conditions of learning by attempting to engineer and sustain educational innovation in everyday settings” Bell (2010, 243).

Anderson and Shattuck (2012) argue that a quality design-based research study has five characteristics. It: is situated in a real educational context; focuses on design and testing of a significant intervention; uses mixed methods; involves multiple iterations; and involves partnerships between practitioners and researchers. Wang et al. (2005) combines two of the essential elements; interactive and iterative, which match the “mixed methods” and “collaborative” criteria used by Anderson and Shattuck (2012). In essence Wang et al. are therefore defining a sixth characteristic, “contextual” which focuses on the nature of the findings and their generalisability. Table 3, below summarises the essential elements of each author and the similarities and differences in their approach.

Characteristic	Wang et al. (2005)	Anderson & Shattuck (2012)
1.	<p>Pragmatic</p> <p><i>Researchers focus on practical issues, refining both theory and practice.</i></p>	<p>Situated in a Real Educational Context</p> <p><i>Results are used to “assess, inform and improve practice”.</i></p>
2.	<p>Grounded</p> <p><i>Research is informed through the selection of a theory about learning and instruction.</i></p>	<p>Focused on the design and testing of a significant intervention</p> <p><i>The intervention is informed by relevant literature, theory and practice from other contexts.</i></p>
3.	<p>Interactive, Iterative and Flexible</p> <p><i>Collaboration between participants and researcher occurs. There is an iterative cycle of design, enactment and implementation. Designs are flexibly adaptive consistently with principles of learning</i></p>	<p>Involving Multiple Iterations</p> <p>Involving Collaborative Partnership between research and practitioner</p> <p><i>“Design practice evolves through the creation and testing of prototypes, iterative refinement, and continuous evolution of the design as it is tested for authentic practice” (p17).</i></p> <p><i>A partnership between researcher and practitioner occurs “from initial problem identification through literature review to intervention, design and construction, implementation, assessment and to the creation and publication of theoretical and design principles” (p17).</i></p>
4.	<p>Integrative</p> <p><i>A variety of approaches is used</i></p>	<p>Using Mixed Methods</p> <p><i>Mixed methods are generally used involving</i></p>

	<i>including survey, expert review, evaluation, case study, interview, inquiry method, and comparative analysis. "Methods may vary as new needs emerge".</i>	<i>a variety of research tools and techniques.</i>
5.	Contextual <i>Results are connected both to the design process through which results are generated and the setting where research is conducted. "The generalisability of findings increases when they are validated in successful design interventions in more contexts" Van den Akker (1999: 9) as quoted in Wang et al (2005).</i>	

Table 3: Comparison of Design-Based Research Characteristics

It is arguable as to whether the sixth criteria outlined by Wang et al. (2005) is in fact an additional, discrete criterion, or instead refers to the defining purpose of DBR: to develop design criteria that can be applied in other contexts. For example, the design-based Research Collective (2003) states that one of the characteristics of design-based research is that research needs to lead to shareable theories that help other educational designers. This study uses the five characteristics as defined by Anderson & Shattuck (2012). These are discussed in more detail in the following section.

4.3.1 Situated in a real educational context

Bell (2010) states:

Given the interventionist nature of the work at hand, it is also important to realize that the range of educational products that can become the focus of educational design-based research is quite broad. Design research might focus on the development of novel learning technologies or software ... on a semester long curriculum sequence and associated instructional techniques ... the design of a teacher education program ... formation of an extended community of practice. In sum, complex interventions in education amenable to design-based research take many forms (p244).

Amiel and Reeves (2008), in promoting the importance of design research as a method to inform research in educational technology noted the importance of characterising technology and techniques “as processes rather than artefacts” and on the “values and principles guiding educational technology research” (p31). Design research further allows regard to be had to the complex interaction between technological interventions, the roles of educational institutions and the meaning of research.

(If) technology is recognised as a process rather than a mere artefact then two things occur. First researchers must begin to question their research methods due to the complexity of the environment under study, Second, researchers must question the values that are guiding research agendas, actively engaging with practitioners in constructing what constitutes

valuable research in order to help direct technological development rather than react to it (p32).

Several of the more recent studies have investigated: the design of a web-based learning environment to improve students' motivation to learn science (Wang & Reeves, 2006); the re-design of vocational education (Leeman & Wardekker, 2011); design of a prototype for a technology-based innovative learning environment (Ma & Harmon, 2009); the design and implementation of an on-line community of language learners (Marden, 2008); learning through web-based multistoryline case studies (Zeng & Blasi, 2010); development of a teachers' support system for behavioural issues among students (Hung, Smith, Harris & Lockard (2007); a study to support lecturers in improving practice with on-line delivery (Voight & Swatman, 2006); and web-enhanced case-based activity (Kim & Hannafin, 2006).

4.3.2 Focused on the design and testing of a significant intervention

In analysing the design-based research studies, Anderson and Shattuck (2012) note the use of literature, theory and practice in determining an intervention. In this situation the researcher uses theory to inform a design solution that attempts to both understand and improve educational processes. The researcher then “creates artefacts that embody these hypotheses and places them in the real world for testing” (Joseph, 2004: 236). Wang et al. (2005) support this view “before conducting design-based research, researchers select a theory about learning and instruction”.

A number of the studies that were examined reference what DiSessa and Cobb (2005) refer to as Frameworks for Action (p81). Case-based reasoning underpinned a number of these studies: Kim & Hannafan (2006); Voight & Swatman

(2006); Ma & Harmon (2009). DiSessa and Cobb (2005) caution on the reliance in DBR on frameworks for action, arguing that there is often a “gap” that arises from the fact that instruction is the result of many complex, interacting elements. They therefore argue that a critical element in design research is to understand and manage the gap that separates theoretical claims from other aspects of design.

Kim and Hannafin (2006) refer to case-based reasoning as underpinning the design of web-enhanced case-based learning. Their paper defined the theoretical assumptions and principles underpinning the design, but did not test the principles in practice. The reader is left to question: the range of assumptions that were made about the development and transfer of cases to an online environment; the role of experts and how that would be incorporated on-line; and the way in which peer collaboration would be scaffolded. Similarly, Ma and Harmon’s (2009) review of case-based reasoning and the theoretical principles for case-method learning failed to clearly identify the gap that differentiated the theory-based literature studies from the reality of the challenges designing an effective on-line environment. They over-simplified the research problem when they framed the research problem as one of content and tools.

Voight and Swatman (2006) also relied upon case-based reasoning as the Framework for Action in the study of on-line undergraduate teaching courses. In contrast to the research described above, this research clearly focused on the challenge of moving case-based teaching onto an on-line environment, noting issues that occurred with practitioners and learners with regard primarily to the level of student interaction and level of instructor intervention. The Voight and Swatman

(2006) research clearly identified the need to understand the relationships among interaction, learning and communication technology.

Marden (2008) in the design of an online environment for second language collaborative learning, focused on community of practice as the framework for action. However, by then incorporating designated activities (informed by Vygotsky's sociocultural theory (1978), it was difficult to then determine the extent to which the outcomes were informed by the task design, or the effectiveness of the on-line learning community, particularly as phase 1 research directed the author toward the community-of-practice approach. This limited the generalizability of the design principles.

In contrast is the approach adopted by Wang and Reeves (2006), which focused on the theory of learning motivation, and systematically sought to understand the way in which the individual factors of challenge, control and fantasy could be incorporated successfully into the instructional design of a web-based learning tool.

Mingfong, Yam San and Ek Ming (2010) focus not only on the theoretical basis of an intervention, but also on the design process itself. They postulate that a design-based research project aimed at transforming learning with technology requires the appropriate alignment of four design components. These are: frameworks for learning, affordances of the chosen instructional tools, domain knowledge presentation, and contextual limitations. They claim that in reality, the contextual limitations such as culture and structure, often dominate the other design components. Previous attempts at design of knowledge management systems for teachers are described in chapter 2 and would indicate that the culture of schools and teaching is

likely in this research to be the dominating factor that impacts the effectiveness of the design.

4.3.3 Mixed methods

Brown (1992) noted that components (in classroom-based learning) rarely occur in isolation; the whole is really more than the sum of its parts. The learning effects are not even simple interactions but highly interdependent outcomes of a complex social and cognitive intervention (p166). This calls for new and complex methodologies or “hybrid” methodology (Wang & Hannafin, 2005, 5).

Shavelson, Phillips, Towne and Feur (2003) emphasise that the research question is the driver of the research methods, and the question is itself driven by the phase of the design. In the “discovery” or problem analysis phase, open-ended exploration is common. In this phase, survey, ethnographic, or case-study methodology can be used along with “context and motivation” to create a narrative that “might suggest possible explanations and ways for redesigning learning environments or instructional artefacts” (p28). Kelly (2004) similarly emphasises the need for “stage appropriate” use of research methods (p125). Zeng and Blasi (2010) and Marden (2008) failed to apply adequate methodology during the discovery phase, impacting on the usability of the first design iteration. This is further described below in discussion regarding the importance of collaboration.

In contrast, Hung et al. (2007) used focus groups during the discovery phase to determine the scope of the problem. This was supplemented by a user profile survey to determine participant experience with both computer usage and the focus area,

classroom behaviour management. Based on focus group outcomes, five modules were selected for development during the first design iteration.

During the development and iteration phases data collection and analyses methods used in quantitative and qualitative research may be used (Orril, Hannafin & Glazer, 2003). Marden (2008) adopted qualitative processes using recording, note taking, class observation and focus group interviews in determining the effectiveness of the on-line learning environment. This was repeated during the second iteration with the addition of a questionnaire to obtain background information regarding participants. In contrast, Hung et al. (2007) adopted a quantitative approach using a seventy-five question survey divided into three main constructs: instructional features, interface and orientation, and technical accuracy. Significantly, differences in outcome occurred between the subject matter experts and the participants highlighting the importance of design research that is focused on user requirements as opposed to a design paradigm of building what experts believe is required. The rigour of the approach adopted by Hung et al. (2007) allowed the differences to be surfaced and for further collaboration to occur, resulting in a significant design change and the establishment of a matrix-module approach.

Guba and Lincoln (1981, 1982, 1989) developed the criteria of credibility, transferability, dependability and confirmability to determine the rigour of qualitative studies. To these criteria, in iterative design research, Smaling (1990, 6) adds the criteria of trackability: the need to report the failures and successes of each design iteration, and the procedures followed on conceptual framework used, and on the reasons for the choices made. Wang and Reeves (2006) used multiple sources (student and teacher interviews, motivation questionnaires, and observations) to increase the

rigour of the study. Triangulation strategy (Denzin, 1978) was used to increase the dependability from the multiple data sources and methods. Observation protocols were established to ensure that two observers conducted classroom observations and the discussed findings. Interview protocols were also established. These processes increased the credibility and dependability of the findings.

4.3.4 Involving multiple iterations

The frequency and number of iterations varies throughout the research that was examined. In developing a system to support classroom teachers with student behaviour problems, Hung et al. (2007) adopted a six-phase rapid prototyping process. Referencing the work of Jones and Richey (2000), and Tripp and Bichelmeyer (1990), this approach involves the development of a small-scale version; a prototype that can be applied in a short period of time that has the characteristics of the full-scale version. Chapter 5 describes how this approach is adopted in the development of the knowledge-management system for teachers.

Whilst multiple iterations are considered a characteristic of DBR, it should be noted that there have been single iteration studies; Ma & Harmon (2009) and Drexler (2010). Ma and Harmon (2009) used single iteration to develop a prototype of a technology-based innovative learning environment. Using the framework established by Reeves (2000), described in the process section below, Ma and Harmon (2009) developed sub-steps that defined the methodology adopted. In contrast to the rapid prototype methodology used by Hung et al. (2007), Ma and Harmon (2009) adopted the approach of a “vision prototype (Erickson, 1995), a minimalist prototype that supports a few scenarios” (p81). Design principles were developed that related

primarily to the purpose, content and use. However a limitation on the single iteration model was that collaboration did not extend into use of the product and to the evaluation of whether the system design met the practical purpose or problem that it was addressing. To this end, further iterations over a period of use would have strengthened the research findings. Drexler (2010) also adopted a single iteration model similar to that developed by Ma and Harmon (2009). In conclusion, the researcher notes the limitations of the study and that in the single iteration “other instructional options were available that were not fully explored in this study”. Whilst DBR has been applied to single iteration studies, multiple iterations have the value of ensuring greater engagement with the user in application to the identified problem; and the possibility of broader analyses that may make design principles more generalisable.

4.3.5 Involving a collaborative partnership between researchers and practitioners

Barb and Kirshner (2001) describe DBR as challenging the assumption that research is contaminated by the external influence of the researcher. In defence of design experiment, Brown asserts that in DBR participants believe that they have some control over their own conditions during the study, that is, “they (are) truly consultants or co-investigators in the research endeavour” (p165). This has characterised the design research, where Brown states that “control” as understood by the above definition, is one of the things she sought in her classrooms. Scardamalia and Bereiter (1983) similarly wanted students to act as co-investigators of their co-learning. Collaboration between researchers and participants in the design and systematic implementation and refinement of the design, has strengthened the bringing together of pragmatic and theoretical outcomes affecting practice.

Leeman and Wardekker (2011) note the importance of the researcher maintaining a clearly defined role in the process and ensuring that collaboration does occur with critical participants. In this study, the researchers were invited to evaluate a vocational education program that involved students undertaking work experience at a local park. Working with teachers and project leaders, the aim was to improve the pedagogical course using data obtained from interviews, observations and reflective meetings. Funded by government grant, the researchers failed to account sufficiently for the context within which the intervention occurred and did not involve adequately teachers who “felt that some of their responsibilities had been taken from them” (p325).

Upon reflection, we can see that our initial lack of insight into the structure of the project organisation and our position severely hampered our possibilities as researchers to be real participants in what the project staff and teachers were thinking and doing ... What was lacking in our eyes was insight into the possibilities and limitations of design-based research on the part of the project participants, and also on our own part. What we (should) have noted ... the teachers tended to remain on the outside and were not seen, and did not see themselves, as carrying responsibility for the course of the project (p329).

Leeman and Wardekker (2011) failed to give appropriate attention to the real-world context and had failed to investigate adequately the ethnographic questions: “what are the norms of local culture? How is power managed and shared? How does learner motivation operate in this setting?” Joseph (2004: 236).

Other researchers have similarly not used adequately collaborative and participatory processes to ask other important preliminary questions such as “How are artefacts used? How are they implicated in the learning? How do they fail?” Joseph (2004, 236). Marden (2008) describes no participant involvement in the discovery phase, instead relying on literature reviews to scope the problem. This approach could be criticised as not collaborating adequately with instructors or students in defining the scope of the issue. Similarly, Zeng and Blasi (2010) relied solely on the literature review and an instructor, using secondary source data of student evaluation data rather than direct student input, in designing the first iteration of a case-based instructional tool for pre-service teachers. It is therefore not surprising that students showed no interest in multiple storylines or the layout of the case studies. Whilst student feedback was incorporated into later iterations, the importance of phase I involving the analysis of practical problems by researchers and practitioners in collaboration, as outlined by Reeves (2006) becomes apparent.

In contrast, Hung et al. (2007) in designing a performance support system for teachers worked with a focus group of 13 high school teachers to determine a solution that did not involve mere technical integration of units but which ensured that material was integrated instructionally. Through the process of rapid prototyping supported by collaboration, the system was refined “until satisfactory outcomes (were) reached by all concerned” (Reeves 2006, 59). Hung et al. (2007) also involved multi-discipline “experts” in the collaboration, including university professors from instructional development and special education respectively, a paediatric doctor, a retired special education teacher, a clinical psychologist, and a software engineer who specialised in relational database development, and additional content experts.

4.4 Relevance to this Research

Studies into on-line e-learning incorporate design features that pose similar instructional outcomes required for a knowledge-management system. Hung et al. (2007) sought to design a system that would support teachers' individual performance in resolving daily issues they faced in the classroom and designed a system that incorporated content knowledge and allowed teachers to document and track their own plans. However, the collaborative learning tools and design principles developed had limitations, as the content of the system was designed and modularised in ways that did not encourage collaborative and emergent learning among participants.

A design framework for an on-line knowledge-management system for teacher professional learning has not been fully developed, and there is an opportunity to contribute to the development of such a framework. This study makes such a contribution. In doing so, this research meets the five characteristics outlined by Anderson & Shattuck (2012):

1. The issue of knowledge management to support teacher professional learning has a real educational context. The increasing demands for information and knowledge to be shared across school boundaries has been recognised and staff have requested an information technology solution that allows knowledge sharing. The nature of the problem requires input and perspective of the teachers who deal with the problem on a day-to-day basis.
2. The development of a knowledge-management system involves the design and testing of an information technology solution within the social context of teachers. This will involve "real world" testing that takes into account

the multiple interconnected social influences such as de-privatisation of work, the role of the expert contributor, voluntariness of contribution, frameworks for learning, context, and the usability of the system. Further, the design is required to support web-enabled learning for teachers, having regard to emerging relevant theories of learning including connective theory (Downes, 2006), network theory (Barabasi, 2002) and connectivism (Siemens, 2004), described in chapter 3. Draft principles were created, consideration having been given to the relevant learning theory, existing principles and practitioner input.

3. A mixed-method qualitative approach is used. Described in chapter 5, the methodology adopted methods appropriate to each phase of the process, including focus groups (phase 1), user groups (phase 2), survey and interview (phase 3) and interview (final iteration, phase 3). To ensure credibility, transferability, dependability and confirmability, specific methodological strategies were adopted, and further described in chapter 5. These include observer note-taking and recording during focus groups and interviews, and peer and expert checks when conducting the thematic analysis.
4. This research adopts multiple iterations in the development of a prototype system. This is consistent with the approach taken by Jones and Richey (2000), and Tripp and Bichelmeyer (1990).
5. Practitioners and the researcher worked collaboratively throughout the research in order to design and refine the prototype. Research questions and approaches were modified throughout in response to feedback and the changing context within which the research was undertaken.

Significant literature exists in relation to how to conduct DBR. Common to each approach is that DBR incorporates a series of steps or processes. Collins, Joseph and Bielaczyc (2004) describe 6 steps: implement a design; modify a design; analyse a design; measure variables (independent and dependent); and report on the design research. This scaffold will not be used, as it does not provide for participant collaboration in establishing the initial need for the design solution. As demonstrated by Leeman and Wardekker (2011), and Zeng and Blassi (2010), such a lack of collaboration and failure to give proper attention to the real-world context can lead to failure of the design.

This research has adopted the model developed by Reeves (2006). The steps, referred-to within this study as phases of research, are: analysis of practical problems by researchers and practitioners; development of solutions within a theoretical framework; evaluation and testing of solutions in practice; and documentation and reflection to produce design principles. The model is shown diagrammatically below:

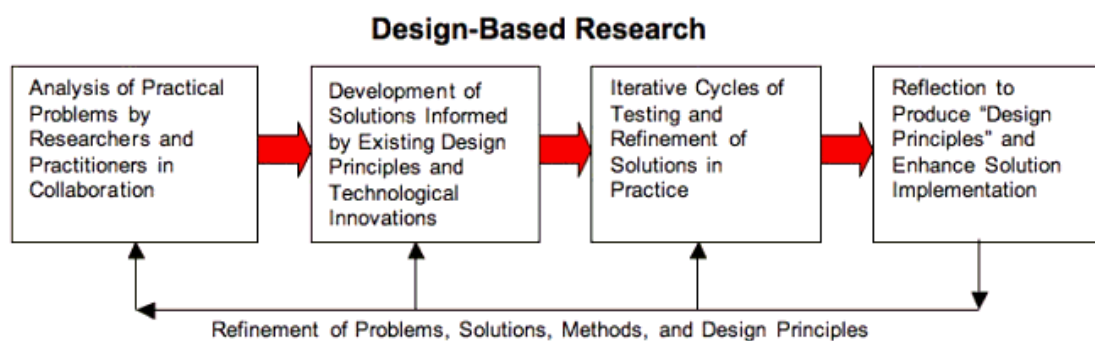


Figure 5: Design-Based Research Approach (Reeves, 2006, p59)

The decision was made to use an adaptation of the Reeves (2006) model, developed by Ma and Harmon (2009). Whilst this variation was initially developed as a means of facilitating single iteration DBR, it provided a more detailed process that was useful in this study. In particular, continued literature review within each phase

ensured that the research questions, the methodology and the design principles remained relevant to the context and the outcomes of the iterations. Subsequent chapters are referenced to the relevant phase in the Ma and Harmon model (2009), varied only by the fact that this is a multiple-iteration study.

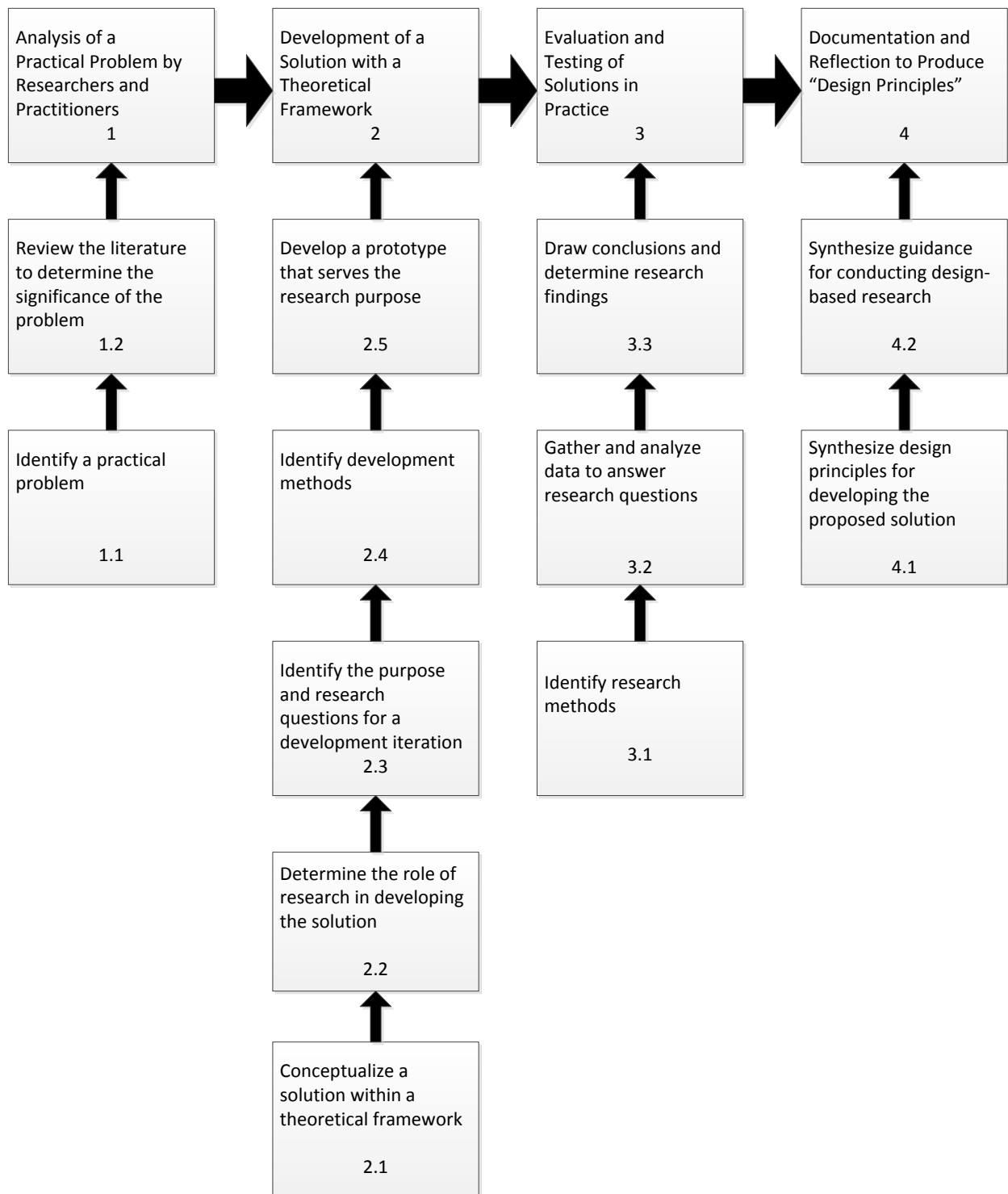


Figure 6: Steps in Design-Based Research (based on Ma and Harmon, 2009, 77)

4.5 Conclusion:

This chapter has outlined the development of Design-Based Research as a research methodology that is particularly relevant to the research question. Whilst this research cannot be neatly categorised within one of Bell's (2010) families or modes of DBR, it does meet the characteristics of combining theory-building in the domain of autonomous teacher-learning and knowledge-contribution, with the development of a practical means by which an on-line tool can be developed to support this aim. Of particular importance, given the previous failed attempts to support knowledge-management for teachers described in chapter 2, DBR ensures that practitioners collaborate with the researcher in developing a tool that meets needs within the context of the practitioner's work. The DBR approach developed by Reeves (2006) is applied, with reference to Ma and Harmon (2009) to describe the activities that are undertaken within each phase or step. The table below summarises the participants, methods and instruments used in each phase of the research outlined in figure 6. These are described more fully in chapter 5, Methodology.

Step/ Phase	Purpose	Participants	Methods
1.	Analysis of a Practical Problem by Research and Practitioners	Researcher Target User Group (n=113)	Literature review Focus group on user requirements
2.	Development of a solution within a theoretical framework – initial design principles	Target User Group (n=15)	Review of existing solutions Focus group of users Literature Review
3.	Evaluation and testing of solutions in practice 1st iteration	Researcher Developers “Expert users (n=17)	Session with “expert” users Survey of teacher users Interview school users (sub-group)
4.	Evaluation and testing of solutions in practice 2 nd iteration	Researcher Reference Group School users (n=12)	Design meetings Interviews
5.	Documentation and reflection to produce design principles	Researcher	Interviews

Table 4: Overview of Methodology by Phases

5 METHODOLOGY

5.1 Introduction

Knowledge management is essentially a human-related process that uses technology as an enabler. As discussed in the previous chapter, a design-based research approach will be used. This study satisfies criteria for a design research approach as outlined in Reeves, Herrington and Oliver (2005), Bannan-Ritland (2003), Design-Based Research Collective (2003) and Kelly (2003):

- Knowledge management is a broad-based complex area and as outlined in the literature review, is an inter-disciplinary field focused on the nature of knowledge, theories of learning, collaborative knowledge-building, and use of technology. It cuts across multiple disciplines: e-learning, technology, and adult-learning knowledge management. It addresses complex areas such as the failure of teachers to transfer what they know beyond the boundaries of their own school unless engaged in face-to-face networks.
- It involves the integration of known design principles derived from literature, and hypothetical principles developed from user feedback to develop possible solutions to a complex problem.
- Inquiry processes were used to test and refine innovations and reveal new design principles. A mixed-method approach, described in this paper, was employed to collect and validate data.
- Prototype development will require on-going engagement with users to refine the protocols for the system.
- The study will require intensive collaboration with teacher practitioners and IT specialists

At the time of writing this dissertation, few if any studies had applied design research methodology to the field of knowledge management. Cobb et al. (2003, p9) examine the purpose of design research in education and state that design research is used because of its focus on learning ecology. This purpose aligns well with the purpose of knowledge-management systems, i.e. to support individual and organisational learning.

The study was conducted in four discrete phases as described by Reeves (2000) and illustrated in figure 7. The outcomes of the first three phases were applied iteratively to refine the overall design principles of phase four.

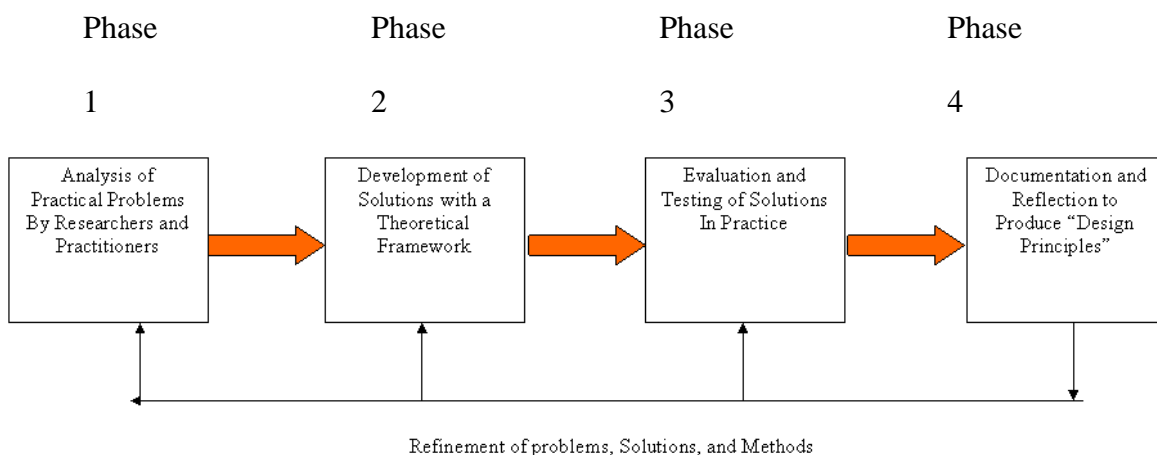


Figure 7: Development Approaches to IT Research

The research methodology utilises a sequential mixed-method design, (Creswell, 2003). A qualitative exploration was used during phases 1 and 2 utilising teacher focus groups and semi-structured group interviews respectively. During phase 3, two discrete user reference groups were used to inform the design principles and subsequent design iterations. A survey instrument was developed to assess the user response to the initial design, and one-on-one interviews to assess the final prototype.

5.2 Ethical Issues – Ethics Approval HE08/150 (Appendix H)

In this study, the researcher had a formal role in the organisation being studied, and was responsible for all human resource functions including the selection, performance management and disciplinary processes of staff. The researcher gave formal undertakings and commitments to participants that there would be no adverse consequences for either participation or non-participation in the research. All letters of invitation and consent issued to participants made it clear that the researcher was working in a private capacity and not in an organisational capacity, and stipulated clearly that participation was voluntary. All data were amalgamated and generalised to protect the identities of participants.

The researcher worked at all times with a reference group that comprised key stakeholders in the organisation within the IT group and the Schools' Services Group. This reference group acted as a critical panel to ensure that the researcher maintained positional independence in the process.

Participants were required to adhere to a code of confidentiality that stipulated:

- Names of students could not be used;
- Names of colleagues should not be used without their permission;
- Information about individual practitioners and practice areas, other than the participant's own, should not be used.

5.3 Phase 1: Analysis of Practical Problems by Researcher and Practitioners

Focus group discussions were used during phase 1 to: explore teacher knowledge-sharing with regard to the solutions currently available to participants; the

suitability of existing teacher-knowledge sharing; and whether teachers perceived a need for the development of a new and different system.

Focus groups have a common purpose of providing insight into how a range of people perceive a situation (Kreuger, 1994; Liamputtong, 2011). The decision to use focus groups, as opposed to one-on-one teacher interviews, was made as the researcher held a senior management position within the organisation and there was a risk that in one-on-one interviews the subjects would modify their answers to indicate support of the organisation's existing knowledge-management platform. Smithson (2000) argues that there is a fundamental difference in the role of the researcher when comparing one-to-one interviews and focus groups. The focus group format allows for a different relationship between the researcher and the subjects, by which subjects are able to engage in open dialogue with each other, and the researcher therefore takes a "peripheral rather than centre-stage role". The critical relationship is not that of researcher and researcher, but rather the inter-relational dynamics of the participants (Kitzinger, 1994; Johnson, 1996). Further, the researcher/facilitator explicitly created a safe, non-threatening environment (Hennink, 2007, 6) by incorporating into her introduction some anecdotes regarding her own familiarity with and use of technology, thereby creating the conditions for participants to be honest about their own levels of use and expertise.

A further distinction needed to be made so that the methodology chosen was not that of group interview, in which the formal direction and control of the agenda and speakers would occur. Rather, the role the researcher took with each focus group was that of facilitator, or moderator, by which the primary discussion that occurred was amongst the participants, and not between the researcher and the participants.

The researcher adopted a semi-structured approach (Morgan, 2002). This allowed the participants to discuss the topics with each other, guided only by a series of open-ended questions used to promote discussion and participation in the group.

Participants within the focus groups were highly engaged in the conversations and the only intervention required of the researcher/facilitator was to prompt new lines of enquiry in the discussion. Participants were open with their opinions and feelings on the issue of existing knowledge-management systems, and the level of criticism that was at times expressed regarding the existing systems and processes indicate that an environment was created in which participants were able to interact and discuss the issues without regard to the organisational position of the researcher. The findings of the focus groups are discussed in the next chapter.

Selection of focus group participants was undertaken with the assistance of a reference group that had been established to provide guidance to the researcher and to ensure that the researcher's organisational position did not influence research outcomes. The reference group comprised the head of information technology for the organisation, and two heads of school services, whose responsibility included the oversight and support of a group of schools within the system.

The constitution of the focus group is one of the critical issues in using this methodology (Parker & Tritter, 2006). Discussions with the reference group resulted in a decision being made not to use randomly-selected teachers in the focus groups but rather to concentrate on "whole of school staff" groups. This decision was purposeful as there was a view that randomly-selected teachers might feel isolated and vulnerable in a group of strangers, and would therefore be less likely to share their true feelings and views about the organisation's existing systems. Both primary

and secondary schools were used in phase 1. As this phase focused on defining of the problem, it was unclear, prior to commencement of the research, whether the challenges for each group were similar and which group would benefit the most from the proposed solution.

Accordingly, nine primary schools were invited to participate in whole-of staff focus group discussions. The focus groups broadly reflected the demographics of the general staff population for age and years of service. This concept of using members of a pre-existing group is referred to by Krueger (1993) as “piggy back” focus group. Kitzinger (1994) and Bloor, Franklan, Thomas and Robson (2001) comment on the benefits that ensue from using pre-existing social groups. In relation to this research, the use of pre-existing groups was preferred as it was more likely to reflect conversations and attitudes that were prevalent in the work environment. However, one risk in taking this approach, discussed later in this chapter, is that members of the group could be less likely to express different or challenging views (Leask, Hawe & Chapman, 2001).

The primary schools selected were single-stream schools (schools of around 200 students that have a single class of students for each year group, typically staffed with around 9 full-time teachers), on the basis that these smaller schools would be more likely to have to look beyond their own school boundaries for support of teacher learning. Two of the schools were also considered to be more geographically remote, having no other Catholic primary school within the immediate vicinity.

Focus groups were also conducted in each of the seven secondary schools of the system. Rather than whole-of-staff groups, these focus groups comprised

volunteers from staff. Each group comprised ten cross-faculty teachers and a member of the school leadership team.

The table below outlines the characterisation of each school. The focus groups were all conducted during scheduled (staff) meeting times, but participation in the focus groups was voluntary. It was made clear through the letter of invitation that any staff member who did not wish to participate was permitted to be absent. Consent forms also referred staff to the reference group if there were any concerns regarding the nature of the research, participation in the research or in how the focus groups were to be conducted. The reference group members were not contacted by any staff member.

The table below lists each of the participating schools, the number of staff from that school who participated in the focus groups and the school location in relation to the nearest systemic school, which provides a broad indication of the degree of school isolation. Each school was provided with an alpha-code, and each participant a numerical code. Accordingly, in chapter 6, participant one from school A is referred to as A1.

School (P) – Primary (S) – Secondary	Participant Numbers	School Size (Number of Pupils)	Distance to Nearest Catholic School
A (P)	A1-A8	202	3km
B (P)	B1-B10	226	1km
C (P)	C1-C8	186	62km
D (P)	D1-D9	147	25km
E (P)	E1-E9	170	12km
F (P)	F1-F13	150	1km

G (P)	G1-G7	230	3km
H (S)	H1-H10	994	13km
I (S)	I1-I10	536	8km
J (S)	J1-J10	1000	30km
K (S)	K1-K10	980	15km
L (S)	L1-L9	1200	8km

Table 5: List of schools showing school size, participant numbers and code, and the school's distance from nearest Catholic systemic school

The school principal participated as a focus group member in the relevant primary school focus groups. The researcher observed carefully for any evidence that focus group members were being restrained in their responses, but did not observe any examples. There was evidence that participants perceived the issue of knowledge-sharing infrastructure as a central-office responsibility, and this belief may well have contributed to the ease with which the teachers discussed and responded to the broad focus areas, despite the presence of the principal and the researcher.

Each focus group was conducted by the researcher, accompanied by an observer/note-taker. The role of the observer was to record the conversation electronically and to take notes on the interactions between participants and information regarding engagement levels. As discussed previously, the researcher undertook a dual role of steering the topic by introducing new areas for discussion, and steering the dynamics of the group.

Because of the nature of the focus groups as intact existing social groups, there was no need for participants to introduce themselves to each other. However, for the benefit of the researcher, participants were asked to identify themselves and to identify in general terms how they would characterise themselves in terms of their use

of and ease with technology. The researcher shared her personal interest and passion for the area of research, and this created a sense of shared experience and interest in the topic, that appeared to enable participants to more easily share their own experiences. Protocols adopted by Parker (2000) were applied, and participants were accordingly advised of the scope of the entire research project, the outline of the broad areas that would be discussed, the process that would be used for data transcription and analysis, and the anonymity of responses in the report. Participants' real names were used by the observer/note-taker for purposes of attributing comments and contribution, however in the final thesis a unique alpha-numeric identifier was used.

A series of open questions (appendix A) was used to explore teacher use of the existing knowledge-management system, "*MyClasses*". This provided the framework for the discussion. Whilst allowing for generative discussion, the researcher guided the conversation to cover the following areas:

- use of *MyClasses*,
- the extent to which it is used for inter-teacher and inter-school sharing of knowledge
- features that are useful
- features not currently available that would facilitate teacher learning
- other sites or forums that are accessed for teacher learning, and if so, what features of those sites meet teacher needs.

Hyden and Bulow (2003) note that the data generated from focus groups comprises both individual and group-level data. It is further recognised, that the impact of group dynamics such as dominant speakers, silence, etc can influence the

views that are expressed (Frankland & Bloor, 1999). Fontana & Frey (2000) stress the need for the mediator/facilitator to be flexible, objective, empathetic, persuasive, and a good listener. Objectivity, in this sense, is defined as the facilitator's task of ensuring that no single participant or partial group dominates. The researcher ensured that all participants were able to contribute by using a process of checking for further comments throughout the discussion, ensuring through eye contact that all participants were invited to speak, and through direct invitation to participants who were waiting for opportunity to speak. Focus group School A was the only focus group in which there was a dominant contributor. However, the analysis of results indicated that the contribution of this individual was coherent with the dominant ideas that emerged from the discussions, and therefore was not seen to impact on the validity of the focus group.

Themes and categories of information emerged from these discussions and these are discussed in the following chapter.

The work of Creswell (2003) and Creswell and Miller (2000) informed the credibility of strategies employed. The first step adopted was the electronic recording of the focus group discussions to ensure that there was accuracy regarding the recording of participant comments. These were then transcribed and cross-referenced with the observer's notes regarding what was occurring within the focus group at different times. Transcripts were analysed for themes and submitted to the reference group for peer review prior to submission to an external academic reviewer who audited the findings. Phase one is described in full in chapter 6.

5.4 Phase 2: Development of Solutions

Phase 1 clearly established that there was a perceived need for the development of a knowledge-management system. The purpose of phase 2 was to inform the development of design principles through the use of semi-structured group interviews that focused on the analysis of existing on-line environments and the extent to which teachers believed that these supported knowledge management (sharing and learning).

Web-site evaluation has no globally accepted definition (Law, Qi, & Buhalis, 2010). Lu and Yeung (1998) used criteria based on functionality and usability to assess effectiveness, whilst Evans and King (1999) and Stern (2002) argue that quantitative data such as the number of hits and other server log data should be used. In this phase of the research, the focus was on whether the sites fulfilled user requirements, and on understanding the factors that users identified as contributing to the usefulness of the site as a tool for knowledge sharing.

The International NGO Training and Research Centre (INTRAC) in its Non-Governmental Organization (NGO) briefing paper (November 2001) discusses qualitative analysis of web-sites. Critical of the work of Sandoval (2000), as using ill-defined criteria, and of the approach of Chivhnaga (2001), as being too simplistic in its use of a checklist, INTRAC proposes an analysis of eight components, being:

Architecture – the logic of pages, their interconnection and impact on navigability;

Technology – the accessibility of the site across different hardware and software capabilities;

Style – The appearance of the web site with respect to layout, text and images;

Content – Quality, authority, readability, relevance and timeliness of text and images and the degree to which user interaction is supported;

Strategy – The degree to which the site meets its stated objectives; and

Management – Resources the site has at its disposal.

These criteria were used to inform the questions used in the site evaluation, phase 2 (appendix B).

During phase 2, participants were referred-to as “evaluators”, as the primary purpose of this phase was to provide feedback on a number of identified sites and the extent to which the site was able to support the strategy, or stated objective of supporting teacher knowledge sharing. Evaluators were invited to complete specified tasks (INTRAC, p4) as this was stated to be one of the better methods for evaluating web-site effectiveness. The stated tasks evaluators were asked to complete included the uploading and downloading of files, the location of specific information and access to social media forums linked to the sites (appendix C).

The school principals acted as gatekeepers and were pivotal in the recruitment of evaluators. Krueger (1994) recognises that the key assumption here is that the “local informant” has access to participants who otherwise would not be accessible, i.e. use of contacts and networks to recruit volunteers. An open invitation was extended to 47 principals to seek up to two volunteers from their schools to participate in the evaluation process. From this request, 25 volunteers came forward. Using principles associated with stratified sampling techniques, the reference group selected 15 volunteers to comprise the evaluator group. This group selection was based on gender, teaching experience and experience with ICT. The evaluator group was thus evenly weighted by gender, by years of teaching experience (divided into

three categories based on less than ten years, ten to fifteen years and over fifteen years) and on ICT experience (divided on the basis of novice/recent adopter, average and confident in their use of ICT).

Three teacher groups were formed, each comprising five volunteers. Each group met for a full day, during which time they were located in the one room, with access to computers. Before commencement of the session, participants were informed about the overall research agenda, the outcomes of phase 1, the purpose of phase 2, and were reminded that anonymity and confidentiality applied to all outcomes of the day. Participants signed a written consent. Each participant was provided with a sheet listing the sites that would be evaluated (appendix D), the tasks that required completion and the critical questions for which feedback was sought.

The researcher led the group through a process that involved locating and using identified sites and then sharing their evaluation of the sites. Each site was projected onto a large screen at the front of the room during the discussion to ensure that the researcher was clearly identifying and understanding the component being discussed.

Rather than have participants complete a checklist or questionnaire, the decision was made to conduct a group interview. Given the small number of participants, specific questions were asked of each participant in a structured manner. Whilst the focus was on individual specific responses, there was also opportunity for the participants to interact. All responses were recorded, and the dynamics of the group discussion noted by the observer. These discussions led, at times, to moderation of the individual responses based on new information provided by other participants, or discussion as to the potential use of the site for different contexts or scenarios. This

process enriched the information gathered. At the conclusion of the specified questions, spontaneous conversation took place between evaluators regarding the relative merits of the different sites. This was not planned, but was recorded and provided further useful insight during analysis of the data.

During this phase, a site developed by the researcher was also shared and evaluated. Using classroom management as the theme, the site allowed the evaluators to assess whether the format in which materials were presented impacted on (their) teacher learning. The specific formats included on the site were case study, narrative, problem-based scenarios and best-practice statements. As part of this evaluation, the evaluators were also asked the open question as to whether there were any other representations that they had used/been exposed to that had facilitated their own learning.

Data from phase 2 were transcribed and cross-referenced with the observer's notes. Participants were allocated an alpha-numeric code to identify them. Themes were derived from the data and submitted to the reference group for initial confirmation followed by auditing from an academic expert.

From this process and the review of literature, a set of design principles for knowledge capture and representation was derived. Phase 2 is described in chapter 7.

5.5 Phase 3: Design and Evaluation of a Prototype

The timing of phase 3 coincided with a major project being undertaken by the Catholic Education Network (CeNet) on the development and evaluation of a number of Learning Management Systems. The Catholic Education Office, Sydney, was asked to work with an organisation, LIFE, on the development of a product. The

researcher was able to work within this process by liaising closely with two personnel in the organisation's Information Technology (IT) Department who had the responsibility for liaising with the third party designer and provider of the software.

The brief for the project was to develop an information-sharing system that would replace *MyClasses* and that could be used among teachers and by teachers with students. Whilst a number of the elements of the Learning Management System were pre-determined, the design principles were provided to the software designers, and some modifications were made.

The prototype was evaluated with a user group comprising 17 personnel. The user group was made up of eight school-based teachers, five of whom were secondary and three primary. There were six e-learning advisors, a central office role that has responsibility for assisting schools in integrating technology into pedagogy. The balance of the group comprised one curriculum advisor, a parent representative and eight staff from the central office.

The group was chosen because:

- 1) The trial period for the product was dictated by timeframes that were beyond the control of either the researcher or the information technology staff who were conducting the pilot. The shortness of the trial period required that the school users were proficient in ICT and were recognised as fast learners and early adopters;
- 2) The school users and central office personnel were all currently experienced in the use of Learning Management Systems (LMS) such as Moodle, *MyClasses* and Edmodo; and

- 3) A parent representative was invited due to the requirement that the system be available and usable by parents in relation to their children's work.

This group was invited to an all-day session during which the functionality of the system, known as "LIFE" was demonstrated by the designers. Evaluators were asked to provide feedback on each area of the system. At the end of this session, the feedback was used to make further design modifications. Evaluators were then asked to continue to use LIFE for a period of two weeks. During the trial, users were provided with suggested activities (appendix E) that would enable them to test the functionality of the system. Support was provided as required by the information technology team. All seventeen participants were then invited to complete a survey, (appendix F).

The survey was divided into five sections. Whilst the language of the survey was translated into non-technical questions that would be readily understood by the users, the theoretical underpinning followed the Website Evaluation Framework outlined in the NGO Policy Briefing Paper No 5 (November 2001). This framework provides evaluation criteria based on architecture (navigability), technology (accessibility and availability), style (appearance), content (interactivity, quality, editing and relevance), strategy (marketing, which in this context translates to regularity of use, purpose of use and sharing of the site) and management (resources).

For the purposes of the survey, these criteria were grouped into four areas for enquiry:

1. Usability for teachers – navigability, style, ability to share with others, ease of use, functional capability, efficiency;

2. Usability for students – navigability, style, content, ability to share with others;
3. Effectiveness of tools – in relation to the four activities, style and content; and
4. Implementation questions – likelihood of broader uptake and use.

As part of the evaluation stage, the eight school participants were interviewed as they completed the survey document and were asked to elaborate on their responses.

The outcomes of the trial period proved inconclusive. For many of the school users the technology issues relating to Internet access and log-ins prevented full testing of the prototype. However, as is described in chapter 7, the overall response indicated the system was not intuitive, was complex and hard to use. Following the evaluation, a corporate decision was made not to invest further in the prototype, therefore there were no further iterations of the initial product.

At the same time as the prototype was being evaluated, Google launched Google Plus. This created a digital networking space that allowed integration of e-mail, cloud-based documents, photos, etc. and allowed for “hangouts” where up to ten people could connect through video. The researcher, in discussion with the information technology group saw the potential within Google Plus to deliver the features that teachers had identified in phase 1 as being important. Accordingly a new prototype was developed within the Google environment using the initial design principles as the framework. With the development of the new prototype, the decision was made to target three schools that were early adopters of the Google environment. In discussion with the principals of these schools, it was determined that all of the

schools were working on the issue of boys' literacy, and it was agreed that the prototype would focus on Stage 4 Boys' Literacy.

For the second prototype, a new reference group was formed to guide the research. This group comprised the director of knowledge management and information technology, the senior e-learning advisor, and the e-learning coordinator from each of the three participating schools.

Interviews were conducted with each of the e-learning coordinators to validate staff use of the Google environment and the focus of boys' literacy in each school.

School A had not at the time of the prototype development fully rolled out the Google environment, but was scheduled to do so in the period ten weeks prior to the projected use and evaluation period of the prototype. Boys' literacy was confirmed as a school priority, although as this was a coeducational school the priority was around good literacy strategies as opposed to boys' literacy specifically. The coordinator advised that all staff had incorporated literacy goals into their individual annual review process, and that the school had an established learning committee focused on, among other things, writing skills for boys. School A was recognised within the system for excellent academic results. The coordinator was agreeable for the school's participation in the trial and his own involvement in the reference group. He was however, cautious in so far as his experience with staff at the school had led him to believe that there was a low tolerance for software solutions that did not work effectively, and wanted to ensure that participation in the trial would be a positive experience for the staff concerned.

Schools B and C had fully implemented the Google environment and staff were familiar with its use. Both of these schools were years 7-10 boys' schools.

School B was located in a low socio-economic, high English as a Second Language (ESL) environment whilst School C was located in a high socio-economic, predominantly Anglo-Saxon environment. School B was particularly keen to participate as the principal and coordinator saw greater opportunity to learn from the activities and approaches of the other two participating schools. School C was motivated to participate as the coordinator had implemented processes for the in-school sharing of materials and wished to develop sharing across school boundaries. Both coordinators agreed to participate in the reference group. All coordinators agreed that the timing of the research was good, and that it reflected what schools were doing.

The reference group met on four occasions during the design of the prototype. The group was positive about the use of the Google environment and the capacity of the prototype to allow files to be uploaded, accessed and comments made. The reference group used and trialled tools in Google Plus, including on-line conversations enhanced through synchronous display of files and videos. Through this process the design of the prototype was developed. The coordinators were granted author rights during the trial to allow them to make further changes to the site in response to user requirements.

The reference group was consulted regarding an appropriate way to launch the site. There was a reluctance to have the site disseminated beyond the three schools, even though the central office members of the reference group were proposing to use the site as a demonstration site during on-going Google training that was being progressively rolled out to other schools.

The trial took place for a period of 20 weeks. At the suggestion of the reference group, the prototype was launched through a videoconference through which the Stage 4 Literacy teachers at all three locations were linked. This provided an opportunity for the researcher to describe the intention of the project, to demonstrate the site, and to emphasise the ability of the teachers (through the e-learning coordinators) to modify the site as they used it to suit their needs. The teachers, 12 in total, were invited to introduce themselves and to describe their work. All teachers indicated an enthusiasm for the project. Teachers at school A enquired as to whether time would be made available to them to use the site. The e-learning coordinators at all three sites advised that this could be provided on request as part of the literacy agenda. There were no set tasks for the users to complete, as the intention was to have the prototype operate within the normal day-to-day parameters experienced by teachers.

During the trial period the researcher did not intervene. On completion of the trial period, a series of interview questions was developed based on validated items from prior research on a technology acceptance model (Venkatesh & Bala, 2008) and literature regarding activity theory.

The technology acceptance model examines perceived usefulness and perceived ease of use and its impact on the adoption of technology.

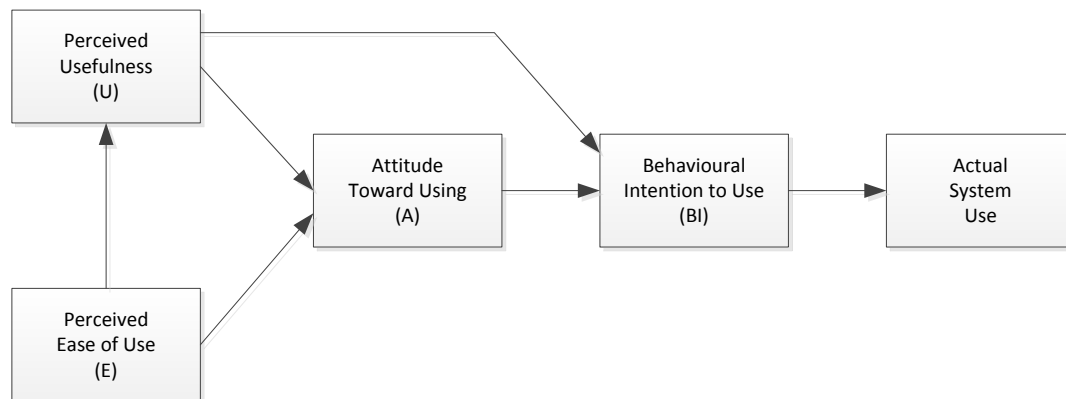


Figure 8: Conceptual Research Model (Davis, Bagozzi & Warshaw, 1989, 985)

There has been some debate regarding the relative importance of perceived usefulness and perceived ease of use. Davis (1993) argued that perceived usefulness was four times more likely than ease of use in predicting adoption of new technology; Igbaria & Tan (1997), that the industry and imperatives for adoption impacted on the relative importance of each; and Agarweal & Prasad (1997), that an unfriendly user experience can impact on the appreciation of users of the system's usefulness. Given that the relative importance of each appears to be domain-dependent, the interview questions were designed to assess the impact of these subjective norms in the research domain, which was educational and based on voluntary usage.

Ease of use questions were designed based on:

1. Access levels;
2. Ease of use of the data base; and
3. Perceived quality of the codified knowledge.

Perceived usefulness questions were designed having regard to the work of Venkatesh and Davis (2000) who extended the technology acceptance model to incorporate response to social pressure. Accordingly the questions focused on:

1. Relevance to the job;
2. Perception regarding the degree to which the prototype was applicable to job output;
3. The match between use of the prototype and job goals; and
4. Results of using the prototype.

However, multiple elements impact on the outcome, including the willingness of teachers to contribute knowledge, the way knowledge is stored and shared, availability of tools and related materials, motivation of the user, the practical way the user relates to these elements, and ultimately the application of the learning in the classroom. This link between individual and social levels is critical in order to realise the action (knowledge sharing) that is for the purpose of transforming the teacher through learning. Technology acceptance theory does not sufficiently examine the user within the context and activity theory was therefore used to structure additional questions for interview. The interview questions and their informing construct is outlines in the table below:

Construct	Item Type*	Question
Perceived Usefulness	<p>Subjective norm – the degree to which an individual perceives that people important to them think he/she should use the system.</p> <p>Image – the degree to which an individual perceives that use will enhance his/her status.</p> <p>Job relevance – the degree to which an individual believes it is relevant to the job.</p> <p>Output quality – the degree to which an individual believes the system will assist them to perform job tasks well.</p> <p>Result demonstrability – the degree to which an individual perceives that results of using the system are tangible and observable.</p>	<p>Can the use of on-line collaboration with other teachers make you a better practitioner? How?</p> <p>Can the use of on-line collaboration with other teachers help you to achieve the specific goals that have been set for you? How?</p> <p>Does on-line collaboration and learning address your job-related needs? In what way? Support critical aspects of your job? How? Improve the quality of the work you do? In what way?</p> <p>Was the site useful to you in your job?</p>
Perceived Ease of Use	<p>Computer self-efficacy – the degree to which an individual believes that he/she has the ability to perform the task/job using the computer.</p> <p>Perception of External Control – the degree to which an individual believes that resources exist to support use of the system.</p> <p>Computer anxiety – the degree of apprehension or fear when faced with possibility of using computers.</p> <p>Perceived enjoyment – the extent to which the activity is enjoyable.</p>	<p>How easy was it for you to use the boys' literacy site? Did the site enable you to complete your tasks?</p> <p>How are ICT resources managed and supported in your school? Did you have the resources you needed to use the system? Was the site compatible to other systems you use?</p> <p>How comfortable were you in using the site?</p> <p>How flexible was the site in meeting your needs? Was</p>

	<p>Objective usability – actual level of effort required to complete specific tasks.</p>	<p>use of the site clear and understandable? How easy was it to use the system to do what you wanted it to do?</p> <p>How easy was it for you to remember how to perform tasks? How much effort was required?</p>
Activity Theory	<p>Goals and sub-goals target actions – the degree to which goals are integrated into individual target actions.</p> <p>Role of technology – the role of technology in achieving the target actions and norms that operate in relation to the target goal.</p> <p>Learning – in what way is knowledge distributed and accessed?</p>	<p>What is the school goal regarding boys' literacy? What does this goal mean to you in your work? How do you work with other people in reaching this goal?</p> <p>Can your job be made easier by collaborating with other teachers? How?</p> <p>What electronic networking occurs between you and other parts of the system? For what purpose?</p> <p>What is the predominant mode of professional development utilised within your school? What peer collaboration occurs with colleagues outside your school? How are new and innovative teaching practices shared between teachers at your school and teachers of other schools?</p>

Table 6: Interview Questions and the Construct from Which they are Derived

* From the work of Venkatesh and Bala (2008)

The components of activity systems are not static (Barab et al., 2002), but are dynamic and continually interact with other components. In order to understand these interactions more deeply, and to explore any contradictions or tensions that arose during the trial, the decision was made to conduct interviews around the key questions rather than to develop a survey. Eleven of the twelve teachers participated in the interviews that were approximately of one-hour duration. The twelfth teacher was unavailable due to an extended absence from work, but provided her thoughts to the interviewer through a written report. This contribution was not in response to interview questions but reflected the teacher's experience.

The researcher visited each site and conducted individual semi-structured interviews during which each teacher was given opportunity to respond to each of the questions. The semi-structured format allowed the order of the questions to be changed to facilitate a more conversational style to flow, and encouraged the researcher to probe and ask additional related questions to clarify meaning. The interviews were recorded and notes taken by the researcher.

General interview protocols were followed, as outlined by Rowley (2012). The researcher:

- introduced herself and made clear that she was acting in a personal capacity as a researcher and not from her organisational role;
- explained the purpose of the research and thanked the users for their willingness to contribute to the pilot; and
- noted that use of the site had been low, but that this was not an issue, as the data, whether favourable or not regarding the pilot, offered important insight

into the research questions, the user thus being encouraged to be absolutely honest in answering the questions;

- clearly outlined the amount of time the interview would take;
- sought permission for recording of the interview; and
- assured users of confidentiality, and that names would not be used in the research.

Following the interviews the notes and recordings were transcribed, and the researcher listened again to the recordings, making notes against the transcript of hesitations and other personal responses that the users exhibited in responding to the questions.

5.6 Phase 4: Documentation and Reflection

During the final phase the interview, data and outcomes were reviewed, analysed and a thematic analysis conducted. The themes were checked with the reference group and with an independent academic researcher. These themes informed the final analysis and the development of design principles that can be applied to the construction of knowledge-management systems in education.

5.7 Conclusion

The use of design-based research methodology as described in chapter 4 required that the researcher collaborate extensively with teacher practitioners regarding both the perceived need for, and design of a knowledge management and collaboration site that was purposeful in meeting their needs. This chapter has:

1. Described the process followed by the researcher in selection of those practitioners;

2. Outlined the decisions made regarding data collection, recording, analysis and interpretation;

3. Described steps taken to ensure validity (through credibility, neutrality and conformability strategies) and reliability (by ensuring consistency and dependability of the data); and

4. Outlined the procedures that were followed to ensure effective management by the researcher of the ethical considerations associated with the researcher's role within the organisation.

Ensuing chapters describe in detail each of the phases of the research, and demonstrate the iterative nature of this research methodology. As outlined in Chapter 4, the design research model of Ma and Harmon (2009) was used as the scaffold for each research phase. In this model, outlined in the diagram below, the numbering sequence follows the design phase steps. Phase I of the research therefore incorporates:

1.1 Identify a practical problem

1.2 Review of the literature to determine significance of the problem;

and

Analysis of a practical problem by researchers and practitioners

This phase is described in Chapter 6.

Subsequent chapters relate to the diagram as follows:

Chapter 7 - Phase 2: Development of Solutions Informed by Existing Design

Principles and Technology

Chapter 8 – Phase 3: Iterative Cycles of Testing and Refinement of Solutions in Practice

Chapter 9- Phase 4: Reflection to Produce “design Principles” and enhance solution implementation

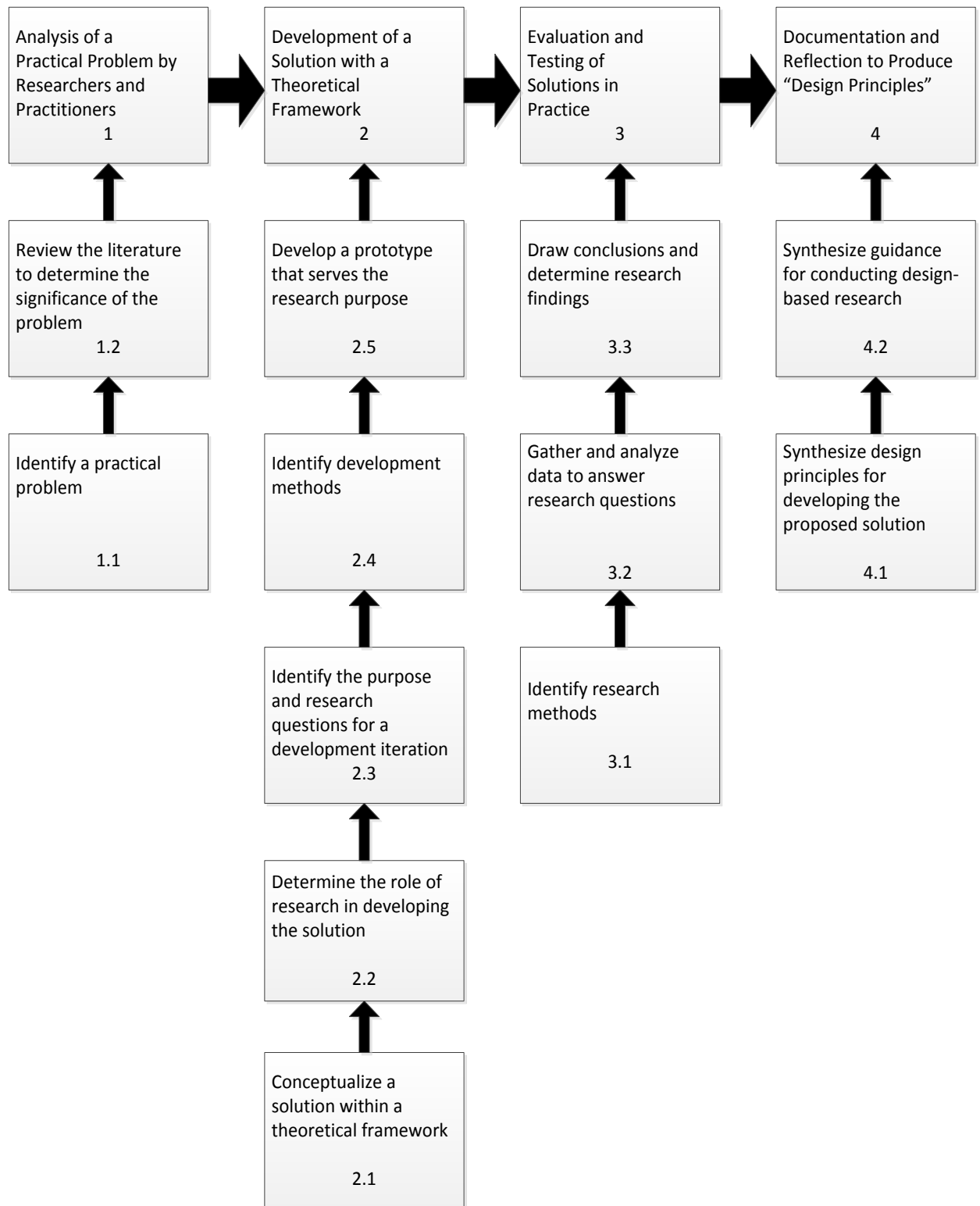


Figure 9: Steps in Design-Based Research (based on Ma and Harmon, 2009, 77)

6 PHASE 1 – ANALYSIS OF PRACTICAL PROBLEMS BY RESEARCHER AND PRACTITIONERS

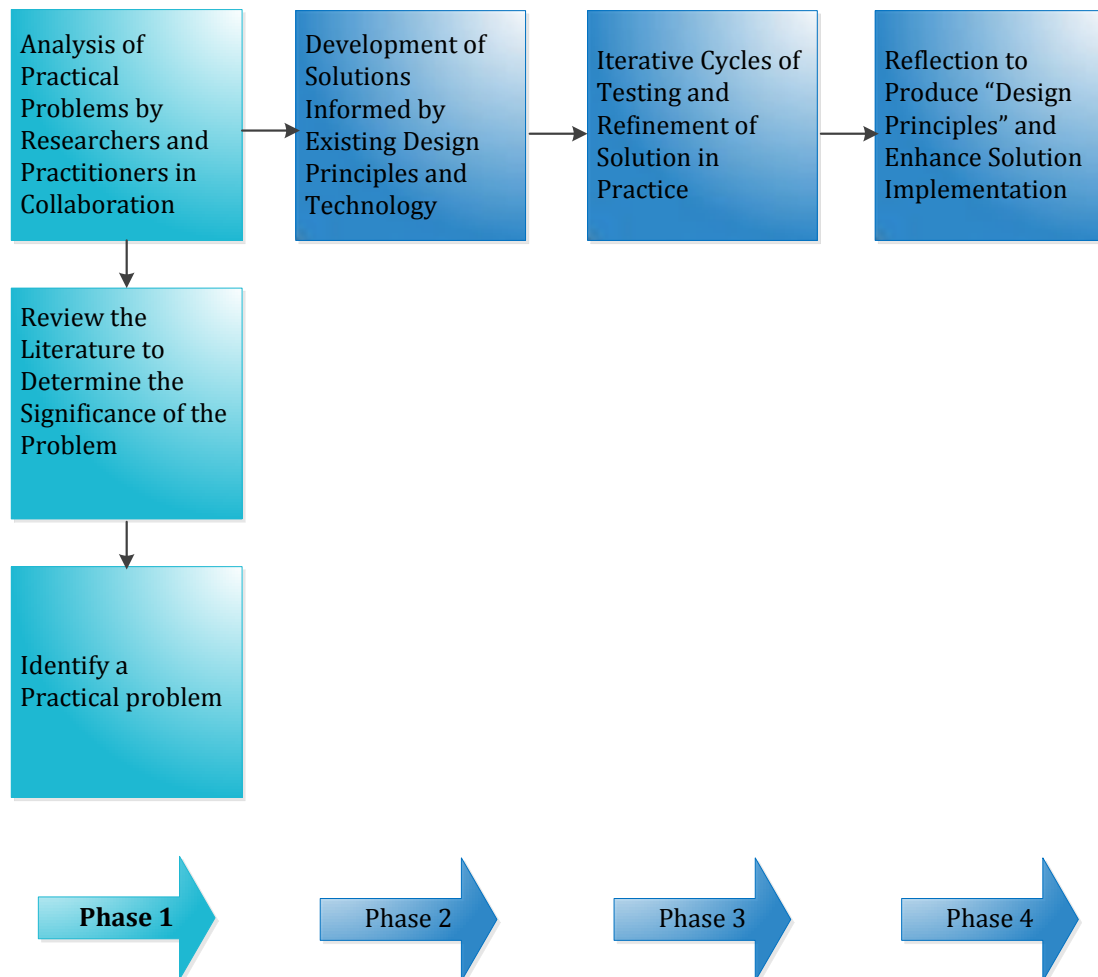


Figure 10: Design-Based Research Phases adopted from Ma & Harmon, 2009: Phase 1 Steps Described

6.1 Introduction

The diagram above outlines the steps undertaken during phase 1 of the research. This phase focused on analysis of teacher use of *Myclasses*, a tool that had been introduced primarily as a single-user platform for teacher use with their students. *Myclasses* had also been designed with capacity for shared teacher use. The focus of this phase was to determine through focus group questions whether shared use occurred; such as evidence of sharing of materials and interactions around questions of practice. Factors impacting on teacher shared use were identified, analysed and evaluated having regard to practitioner feedback and previous studies relating to teacher knowledge sharing. Practitioners identified both the need and desire for an effective knowledge sharing platform and suggested a number of characteristics both social and technical that would need to be present for teacher use to occur.

6.2 Identification of Practical Problem

In 2004 an information technology tool known as *MyClasses* was introduced into Catholic schools across NSW. *MyClasses* provided a virtual learning environment with capacity for class pages, a learning object repository, e-learning portfolios for students and discussion forums. Six years after its introduction, *MyClasses* was predominantly being used by teachers as a tool for students within the classroom. During this same period, schools within the Catholic Diocese of Wollongong (47 schools) developed a School Review and Improvement Plan. This plan required schools, across a 5-year rolling cycle, to assess themselves against eight key areas and to develop local plans to improve performance in those areas. In conjunction with school plans, individual staff members were required to set personal goals related both to school improvement and improvement in their own pedagogy.

Recognising that across the system there was potential for duplication of effort and a failure to learn from the strategies of others, individual teachers and school leaders within the system requested that an information technology solution be developed to support sharing of school practice and individual teacher learning.

Phase one of this research engaged 113 teachers, across 12 schools in an examination of existing patterns of use of on-line teacher sharing, focusing specifically on use of *MyClasses* not as a tool for students, but as a tool to support sharing between teachers in different locations. This phase sought the input of those teachers in defining the problem and assessing whether there was a real need for an information technology solution to be developed.

6.3 Analysis of Problem by Researcher and Practitioners in Collaboration

The researcher and an assistant visited 12 schools within the Diocese of Wollongong and conducted focus groups with teachers. In the 7 primary schools, all teaching members of staff who worked on the day of the visit were invited to participate. A total of 64 primary school teachers volunteered and were part of the study, including the principal and assistant principal of each of the schools. Five secondary schools participated in the study. Secondary schools were asked to invite 10-12 teacher volunteers who represented a cross-section of staff at their school. A total of 49 teachers participated, including the principal of one school and the assistant principals of the remaining four schools.

School	School Type	Code	Participant Codes
Bulli	Primary	A	A1-A8
Warrawong	Primary	B	B1-B10

Milton	Primary	C	C1-C8
Helensburg	Primary	D	D1-D9
Moss Vale	Primary	E	E1-E9
Port Kembla	Primary	F	F1-F13
Gwynneville	Primary	G	G1-G7
Rosemeadow	Secondary	H	H1-H10
Oak Flats	Secondary	I	I1-I10
Bellambi	Secondary	J	J1-J10
Varroville	Secondary	K	K1-K10
Narellan Vale	Secondary	L	L1-L9
			N =113

Table 7: Focus Group Participants Phase 1

Focus groups were asked a series of pre-set questions (appendix A). An assistant took notes at each group, and all focus group responses were recorded. One recording failed, and a second lacked clarity, therefore the observer's notes were used as the record of those schools. All other recordings were transcribed.

It was evident very early in the study that most teachers who participated had access to external resources to support their teaching. This was achieved either through regular access of web-sites for materials or ideas, or through their network of colleagues who were able to be contacted directly through e-mail for exchange of information and resources. Therefore, in addition to the pre-determined questions, a more direct supplementary question was asked of all groups:

“What would a diocesan site have to provide in order to be worthwhile to you, and under what circumstances would you use it in preference to the sites you are already accessing?”

A second supplementary question developed in response to an early indication that teachers were generally comfortable asking colleagues for materials and ideas (peer contribution) but looked only to web sites where they could be guaranteed the quality of the material (expert contribution). Participants were therefore asked to articulate whether they would prefer expert or peer contribution, the value of each and the factors that would encourage or discourage their own participation in a site to which colleagues contributed.

Focus group transcripts were prepared and a thematic analysis was manually undertaken within the five key areas of discussion and enquiry, namely:

1. The current use of *MyClasses* including the extent to which it was used for teacher-knowledge sharing and sharing between schools;
2. Features of *MyClasses* that impact on use;
3. Other sites used and accessed by teachers;
4. The expressed need of teachers for a knowledge-management system; and
5. Other matters raised – peer or expert contribution.

As discussed in chapter 5, the transcripts were independently submitted to the reference group for analysis and cross-correlated with the researcher’s findings to ensure data credibility.

6.3.1 Current Use of *MyClasses*

Within your classroom

MyClasses was regularly used by 68 teachers (54 primary and 14 secondary) as a tool to support the learning and teaching in their classrooms. For other teachers, particularly those in the secondary environment, the functionality it offered was too limited and other solutions were used to achieve similar outcomes.

MyClasses was most commonly used in primary school classes to post student activities such as homework, to supplement units of work with exercises, to post websites, research tasks and revision tasks for work done in class. There was some evidence of stage teachers within a school co-operating to design a class page for a theme of study or around stage outcomes.

Three primary schools (D, E and G) had used *MyClasses* as a tool to support the diverse learning needs of students, enabling teachers to provide extension activities for students to access. These included differentiated literacy activities, or in the case of students having difficulty with reading and maths, additional activities that could be completed at home with the assistance of parents or older brothers or sisters. The ability to link the classroom and home was an important factor in using *MyClasses* in the primary setting. It was regularly used to allow parents to view homework, student work samples, school newsletters and photos. The functionality of having class-only access overcame many of the perceived problems of using “open” web site access for parents.

The only secondary school that described widespread use of *MyClasses* (School L) had explicitly required its use by teachers. Every teacher at the school was required to have a *MyClasses* page that included student assessment tasks and calendars. Many incorporated other features such as PowerPoint™ presentations, links, tutorials and extension activities. Teachers at this school reported that use of

MyClasses to store and disseminate assessment tasks to students, and to receive assessment tasks from students, was more reliable than use of e-mail.

Most of the secondary schools however did not report widespread use of *MyClasses*. Teachers described a wide range of issues, many of which are detailed in the thematic analysis that follows. However, in secondary schools, most teachers have multiple classes, therefore the process of creating and editing classes in *MyClasses* may be too time-consuming. Teachers in secondary schools also described a variety of technical problems associated with the higher volume of access required, including slowness, and classes “dropping out”. Where *MyClasses* was used, it was generally to give students home access to materials such as noticeboards, and in the case of senior students, past papers and answers. Rather than using *MyClasses*, teachers at three secondary schools described using web technology and bookmarking. This was described by teacher (H5):

If you want a list of web pages you can put together a social bookmarking on Delicious and you can put your websites there and direct kids to that ... it's always going to be there and its not going to disappear.

Linking Teachers Within the School

The use of *MyClasses* as a tool to link teachers within the school varied widely.

Two of the primary schools (Schools B and C) used *MyClasses* minimally, preferring face-to-face communication between staff members and the staff room noticeboard for announcements and reminders:

... because we see each other regularly we don't really need to have a separate page (B6)

Things change so quickly it is easier to access something if it is written on the whiteboard (C8)

The remaining primary schools actively used *MyClasses* for teachers to upload and share sites that have been trialled and recommended, to provide resources for special focus areas such as science week, and to share Board of Studies links, readings and materials. Staff pages were also used to communicate notices, policies and pro-formas, playground rosters, minutes of meetings, learning community projects, references, behaviour management plans, agendas, minutes, and professional learning. At three schools (A, D and G) there were examples of individual teachers setting-up pages for all staff at their school. These pages included three religious education sites, one learning technology page, one maths page and one school review and improvement page. These pages were voluntarily set-up and maintained by staff members who generally had a responsibility for the area within their school.

Use of *MyClasses* between teachers of the secondary schools was not dissimilar although tended to be between teachers within a faculty. Within the faculty, staff pages were used for communication, to disseminate information, syllabus material, hand-outs and assignments for each stage.

Specific examples were given of English, HSIE and creative arts faculty pages and a TAS Faculty where *MyDesktop* had been set up as the default homepage for teachers. This page was used for administration, minutes of meetings, timetables, student photos, professional readings, and links to an Information Communication

and Learning Technology (ICLT) blog. It was evident however that most use was of a passive nature i.e. as an efficient means of information sharing, as opposed to an active means of teacher interaction.

... the blog is the easiest tool to use regarding professional dialogue, but isn't used by all the teachers (L8)

Because of the time-consuming nature of *MyClasses*, it was not universally used, and at one secondary school in particular, teachers used e-mail and shared files on the school server as it was seen to be an easier and quicker way to share and access materials compared with *MyClasses*.

We are starting to get a repository, but it becomes very time consuming (K5)

Only one of the secondary schools (I) connected all staff across the school – but not through *MyClasses*. At this school, two particular conditions were operative: the assistant principal was a passionate advocate of the use of technology to connect staff, and had set up a *moodle* environment; and the recently-established school had a goal to deliver integrated and personalised learning to students. The staff did not have their own classes or subject streams, but rather worked as a learning team to develop and deliver both content knowledge and student support. Through *moodle*, staff had access to a professional blog used for three specific purposes: reflective practice, to report back on professional development and to share professional reading. Teachers report that “*there are more readers than posters*,” and reported greater use when there is an explicit connection of the topic with something pertinent to the life of the school at the time.

Linking with Other Teachers in the Diocese

Several diocesan *MyClasses* sites had been specifically created, and teachers were able to search properties posted by other teachers and schools. These properties were the descriptors used by the author to describe their work. The diocesan pages were considered to be owned by the central office personnel, and were rarely updated, contained few resources that were considered to be of limited value, and were not well publicised or known. Searching for properties across *MyClasses* was difficult, as the search function required that searchers knew the exact word or title under which it was saved, including case sensitivity.

Teachers had generally by-passed *MyClasses* as a tool to connect with teachers in other schools. For example, the reading recovery site was not even known to exist by all reading recovery teachers. Yet there was a reading recovery teacher in each of the primary schools. Instead, e-mail from the tutor replaced the use of the class page noticeboard, and group e-mail was used to distribute new pro-formas, meeting details and general communication.

Several schools referred to the religious education site, commenting that it was not being updated and people weren't using it. Another school also referred to the fact that there weren't many resources, and the ones that were there were of limited value.

The preferred way in which most teachers contacted colleagues was through e-mail.

If I found teachers at other schools are doing something through a colleague or a friend or because I've been to an inservice ... I'd e-mail them, but just out of the blue. I wouldn't ring up to ask what they're doing or who I should talk to (A6)

I tend to e-mail friends that have the same year – we share our programs and attach them that way (D7)

However group e-mails were not always welcomed, with several teachers reporting a feeling of being bombarded and wanting to say “you’ve got the wrong person”.

A teacher-librarian blog site had been set-up within the system and this was referred-to by many teachers as being of particular value, allowing teachers to post questions, ideas, photos and ideas for library set-up so others could see how it was done. The site had open access and this appeared to contribute significantly to the usefulness of the site, as it alleviated the problem described earlier regarding the constraints of the search function and the need to know exactly what was being searched-for prior to looking.

It is a great site as it doesn’t depend on knowing what’s there (D3)

There was no current use of diocesan sites recorded from within the secondary focus groups. Reasons for the lack of use were:

- The perceived quality of the resources:

I can get better sites, better information, and easier access – I know where to go and I don’t have to navigate to it, plus through teachers at other schools I find new sites to go to and I’ll go straight to it (E7);

- The absence of an effective search function:

You don’t know they are there (F2);

- The “class” structure required for page membership:

I've got these properties and we will share them and you will invite someone to be a part of your class (D5); and

- The perception of *MyClasses* as a tool for students rather than teachers:

I would never have conceptualised it that way – I always thought of it as a teaching resource for students and their learning rather than a way of connecting with other teachers (E1).

Reference was made to several secondary *MyClasses* pages that had been established by KLA coordinators, including a maths coordinator group, a TAS coordinator group, a Religious Education Macarthur group and a HSIE coordinator group. Only the latter group was still operational. When asked as to why use of the other groups had ceased, the primary reason given was that only a few people contributed resources, whilst others simply “*take what they can get but not reciprocate*”(L2).

6.3.2 Features of *MyClasses* That Impact on Teacher Use

Access

A recurring theme from teachers was the difficulty of access to *MyClasses* both for use with a class, and for use with colleagues. Access issues included the requirement to use a password, the frustration that the password was not the same as used for other diocesan on-line systems, and the requirement to be a class member in order to access particular classes. One secondary teacher (J6) commented, “*a lot of the external sites I use allow you to go from link to link without these steps.*” Also the classes are not “open” so unless an individual has been listed as a class member they cannot access that material. This is a big concern to teachers who might have

developed and contributed materials at their own school, but on transfer to another school can no longer access those materials as they no longer belong to that class –

when people move from jobs or into different roles there is nothing at the beginning of the year to say this person is moving and they should be added to the list or whatever

(K1)

Uploading and contribution of material

As only the class manager can contribute materials, teachers found it difficult to add-to and contribute materials. There were also technical issues, particularly in the secondary environment: for example, uploading new materials to a class page.

Teachers would send a class to a site and it wasn't there ... even though it had been loaded it had timed out and disappeared (B7)

The process of uploading new materials was awkward and time-consuming, and the focus groups stated that *MyClasses* was not easy to use. Further, the material or content of *MyClasses* was seen as static, not dynamic, and many teachers preferred to use other sources for materials.

I am looking for strategies and content – I can't get that from MyClasses

(J3)

Search functionality

The search functionality of *MyClasses* was regarded by all teachers as inadequate as it was cumbersome; not intuitive.

There are brilliant sites in MyClasses yet to access them you need to know the right thing to search under – have to use the right spelling name including capitals that the person has saved it under (A6)

... single-word access (keywords) is too specific, if you don't know the exact phrase there are no matches (F2)

You need to know the right language and links to search the properties and to share them (E3)

System Capability

The information technology infrastructure at the school and its reliability impacted greatly on teacher willingness to use *MyClasses*. In one of the primary schools (School C), *MyClasses* had not been used for several years because of poor connectivity and slow Internet speeds. Even in those schools where *MyClasses* was more widely used, technical difficulties were often experienced.

Sometimes it will time-out on you and the whole class can drop out (C2)

It can be very frustrating when you have spent hours doing something and it 'times out'. We actually started doing a lot of things together at one time and the system just shut down (C6)

System capability also impacted on the types of materials that were loaded onto *MyClasses*:

Excel files went up fine but they didn't download. It has trouble with PowerPoints – something to do with size (L8)

If you put graphics on, it slows to a snail's pace (L5)

Use of Discussion Board Feature

The discussion board feature of *MyClasses* had been trialled widely, but only teachers in two of the focus groups continued to use it (Schools G and L). In two of the primary schools (Schools A and D), discussion features had been trialled as a vehicle to discuss professional reading among staff, but teachers at two of those schools reported that they preferred face-to-face discussion and the discussion board had been discontinued. In a third primary school (School E) lack of time was cited as the reason for discontinuing the practice.

In the secondary environment, there was some evidence of use of discussion board for student/teacher forums. These were scheduled and highly-structured around units of work.

Other themes

Inservicing was provided at the time of introduction of *MyClasses*, but there was no refresher and teachers *“lost a bit (of their skills). Skills and professional learning need to be ongoing not one-off. Teachers are skilling themselves in their own time.” (B5)*

Many of the teachers commented on the lack of access to personal laptops in the classroom, and the lack of reliable computer access at school. This impacted on the ability to effectively utilise the technology. There was consistent recounting of teachers accessing e-mail at home in order to simply keep up with the circulation of school and professional information. There was frustration that this was required. As

a result, this influenced their motivation to use the technology for other professional purposes.

Summary

All users were consistent in reporting the limitations of the *MyClasses* tool, summed up in the comments from one of the secondary focus group participants:

(It is)... clunky and not intuitive (You) ... have to go through too many blocks, performance is just too slow – there are easier ways to do things e.g. one teacher has set up own website for students: bookmarking. It is too time-consuming to add members for a class and edit members of the class, screens, tools and formatting are not nice. (You have) ... limited control over how you customise a page. (I2)

6.3.3 Other Sites Used and Accessed by Teachers

There was clear evidence throughout the focus groups that teachers were accessing the web to support their learning and teaching. Appendix D lists sites referred-to within the focus groups. The sites currently in use fell within three main categories:

1. Repository-type sites – accessed predominantly by primary teachers for materials such as programs, lesson plans, and units of work. Materials were often downloaded and “customised” by the teachers to meet their own specific needs;
2. Student resource sites – accessed by primary teachers to obtain materials to differentiate the curriculum and to supplement class activities, and by secondary teachers to enrich lessons with new and different materials; and

3. Teacher learning sites – accessed by teachers to support their own professional knowledge and growth. Many of these sites were non-interactive and directed to providing knowledge to teachers about curriculum, resources or professional development opportunities e.g. Board of Studies, associations within Key Learning Areas (KLA) such as the English Teachers Association, and the Autism Association sites. There was evidence among a limited number of teachers of use of interactive sites such as Facebook, where teacher-to-teacher exchanges and learning were supported.

A number of the sites in use required annual subscription fees, and three of the primary schools (School D, F and G) involved in the research had school subscriptions e.g. to Teachers Educational Software Solution TESS. There was also evidence that individual teachers were prepared to pay individually for access to sites that they saw as supporting their teaching and learning.

Accessing External Sites

In all schools time was identified as a critical factor in a teacher's use of on-line sites. Most teachers accessed on-line support/facilities in their own time and the perceived tension between servicing the teacher's individual professional learning as opposed to servicing the student learners, was referred-to often.

The functionality and usefulness of sites was therefore critical in determining whether teachers would continue to use a site:

You're not spending half an hour to an hour sorting out and clicking through (E8)

Teachers don't have the time ... they don't want to spend an hour searching and reading. I want someone else to do that for me and to say 'here are the best ones (A6)

Personally I would look for something visual before I'd read it because its instant and often we're sitting down after we've done everything when you get home and you're trying to get ready for the next day and it would be 8 or 9 o'clock at night time (F7)

Teachers identified a range of useful features on the sites they regularly accessed. These features have been mapped against a rubric developed through the University of Hawaii (www.k12.hi.us/-services/1999/webrubric html) for web evaluation criteria. Where relevant, descriptors and quotes have been added.

CRITERIA	Relevance to Teachers
Technical Design (Download speed and supported on multiple platforms)	<ul style="list-style-type: none"> • Free downloads • Documents that are easily downloadable and adaptable – copy, paste, delete, change
Aesthetics (Attractive and entice the user to further exploration)	<ul style="list-style-type: none"> • Simple – clear and uncluttered
Organisation	<ul style="list-style-type: none"> • Organisation in KLAs and stages and strands within the KLAs. The ability to search within

(Well organised and intuitive, easy to navigate)	<p>the KLA.</p> <p><i>There are sites that break-down writing into strands of grammar and spelling – you can get very specific just by clicking onto a button. There are symbols if you want a lesson plan, a power-point, a reference site or just ideas (Teacher C)</i></p> <ul style="list-style-type: none"> • Picture icons that assist in the navigation
<p>Ease of Site Navigation</p> <p>(Pages are interlinked and the links work)</p>	<ul style="list-style-type: none"> • Ease of navigation and short cuts • Easy access back to the home page • Clear links
<p>Use of Graphics</p> <p>(Graphics aid the user and enhance the site)</p>	<i>No Specific Comment</i>
<p>Sounds and Video</p> <p>(Sounds and video load and enhance the site)</p>	<ul style="list-style-type: none"> • You-tube – short and to the point – don't have to watch a 20-minute video
<p>Content</p> <p>(Information and links are clearly labelled and organised; information is</p>	<ul style="list-style-type: none"> • Ability to distinguish between student resources and teacher resources and a descriptor of the item • Information that is correct is important, needs to be current and renewed regularly

accurate and current)	
Currency (The site was recently revised and dated)	<i>No Specific Comment</i>
Availability of Further Information (A contact person/author/e-mail is available)	<i>No Specific Comment</i>
Advanced Design	<ul style="list-style-type: none"> • Forum groups <p><i>I am even a member of a couple of forum groups ... you can go to a forum, ask questions and there is always someone around to answer and you can scroll through, get information and it is so much easier than trying to trawl through ... I can contact people quickly and easily.(Teacher Z)</i></p>

Table 8: Features Identified as Important through Focus Groups and Comparison against Web Evaluation Criteria

6.3.4 Teacher need for a knowledge-management system

Teachers supported the idea of a more effective diocesan knowledge-sharing on-line network. It was seen as a way to share resources and not reinvent materials

already in existence. All of the primary schools expressed an interest in using a site that allowed better sharing of teaching resources.

Some of the individual teacher responses were:

We're all doing something and we're all inventing our own (G1)

If there were ways of making my job easier I would use it (A6)

I'm tired of trying to solve problems for myself in my own classroom (D3)

If you can tap in and make it your own then you could spend more time concentrating on the actual teaching (H 5)

Teachers described the frustration they experienced in trying to identify colleagues who hold knowledge or information that they seek. The opportunity to get fresh ideas and a broader range of experiences from a wider group of colleagues was supported. There was a current practice of teachers using e-mail and linking to teachers they knew from previous professional experience. There was support to develop a system that would expand the ability of teachers to make use of a broader, connected professional network.

(It) wouldn't rely on you knowing a specific person (A8)

You would be able to access other stage teachers (D3)

I could talk about something with people I can't get in touch with because

I don't know (who they are)(F7)

You're getting out of that thing where you are just tapping into the people you know and rely on – you're getting youth and you're getting wisdom and you're getting experiences of different things (G5)

Something that you don't have to know anyone and where I could pretty much go right to my stage. I'm teaching a unit I've never taught before and I could find ideas, how to make it easier (D4)

We are a single-stream school. Three-stream schools are able to share information more. We miss out. As a grade 1 teacher I would like to be able to converse with other grade-1 teachers (C4)

Other potential benefits identified were: a more coordinated approach, creation of more networks and achievement of greater consistency across the diocese.

Focus groups wanted few limits to what could be incorporated in a site and suggested extension beyond learning and teaching material to the inclusion of broader school matters such as school review and improvement, school policies and practices, merit systems, maintenance, school structures, etc.

It could include a broader range of themes – not just content e.g. dealing with difficult parents, bullying and how to talk to parents about it, autism (E6)

Examples of the types of materials teachers identified as useful on a site were:

- Templates that would be customised to meet CEO requirements; for example programs – *I have looked at Parramatta's programs but because they have very specific ways of putting together a program with their own*

format, focus and style ... they have limited value. A site that used the Wollongong approach would be useful and widely used (J7)

- Strategies – *If a child has a particular behaviour problem there would be somewhere to look, read and identify strategies (C4)*
- Curriculum information that is local, and regularly updated.
- Resources – *we would use the standardised units e.g. every science faculty would have a safety unit for year 7; units of work in technology, etc. (K10)*

- Lesson plans, assessment tasks and work samples.
- Resources

I think a resource-sharing listing would be good e.g. top twenty – and peer comments regarding resources (H1)

I am looking for xyz and someone could direct you to a resource (A8)

- Site links
- ... even if they are remotely close to what I am teaching it is better than reinventing the wheel (D5)*

- Video – *show schools that have different learning environments and get teachers to talk about the pros and cons (A6)*

We don't have time to visit different schools. For example, classroom management strategies could be videoed and shared (B1)

- A chat room where you could ask a question of someone

I could ask someone at another school:

how do you do ... (A3)

What would you do ... (K9)

here is a good idea, here is what works (J7)

- Forums –

forums that we could be part of (J5)

forums for each year group – when planning a unit, we would be able to post questions(L6)

Features/Functionality of a New Site

Overwhelmingly, teachers wanted a site that is easy to access and to use. Current and dynamic content was identified by several focus groups as being critical. Good search functionality with keywords and easy navigation were also seen as critical requirements. Colour, together with text size, layout and font, were identified by several groups as being important for usability,. The majority of teachers who participated in the focus groups preferred organisation of material under KLAs, with topics or outcomes as subheadings.

Interactivity among teachers using the site was rated as very important to most teachers in the focus groups. Within the secondary focus groups the creation of a new site was seen as an opportunity to incorporate “modern technology” such as Facebook, Skype, wikis, blogs and RSS feeds.

At School C, teachers stated that they would not use the Internet to contact or exchange information with other teachers. Teachers of this school appeared to be professionally isolated and indicated low involvement in cross-school networks, low familiarity with many of the shared sites and low use of external web-sites. Individuals within other focus groups expressed some reservation as to how and when they would use the site to interact with colleagues, advising that they would be more

likely to use it to seek information as opposed to professional advice. The varied responses regarding intentionality to use an interactive facility indicated that there would still be implementation issues associated with introduction of a new diocesan site, despite conceptual support for the idea.

6.3.5 Other Matters Raised: Expert vs Peer Contribution

Teachers indicated that they were generally comfortable asking colleagues for materials and ideas (peer contribution) but generally looked to web sites where they could be “guaranteed” the quality of the material (expert contribution). Participants were then asked whether they preferred expert or peer contribution, the value of each and the factors that would encourage or discourage their own participation in a site to which colleagues contributed.

There was widespread support within focus groups for peer contribution as this was seen to be real and connected to the day-to-day experiences of teachers.

Yes, I'd be more likely to use things that are from the workplace – they're in the rooms and they're not out of touch. It's current and it's about people posing questions and solving and trialling (A7)

It's trialling and the experience of trialling (F3)

There was, however some caution among past contributors to sites, who reinforced the need for reciprocity in the contributions made by teachers.

It's important that the slackos don't sit back – it has to be something that everyone will contribute to (J1)

I do share and use other people's information; yet I find it is not reciprocated (L9)

During focus groups there was considerable discussion regarding the issue of how the relative merit of peer contribution could be assessed. The importance of recognising all contributions was noted, but participants sought some type of evaluative process. It was recognised that the usefulness of materials could be influenced by a range of factors such as teaching style, cohort of students, etc., and that rather than having a straight rating system, a more useful feature would be to post evaluations, e.g. “this worked”, “that didn’t work”, “this is how I modified ...”

There were several examples of teachers who had accessed the work of others on the religious education website but had not contributed their own. Individuals expressed the difficulty of the written word over face-to-face exchanges:

How am I going to put that down on paper, how am I going to word that?

(B3)

*If you want to publish something it has got to be of a very high standard
... perfect is hard for busy people (D6)*

Teachers expressed reluctance to put up units of work for fear of being criticised or judged.

I would be very particular about writing things down, being professional.

Doubting myself (F4)

My work is not good enough (D2)

*(We’re) not good at selling ourselves – (we) need to know it’s never
perfect and things change continually (J6)*

To overcome this reluctance, various strategies were suggested, including anonymity of postings or by encouraging all teachers in stages to contribute

If you knew that every other person who was accessing it were teaching the same stage you'd be comfortable sharing your resources because you know they are looking to things similar to what you are doing (L1)

Commonality would be important; knowing that everyone else accessing the site was covering these stages would make it comfortable to share units of work (I6)

Knowing that people have the same issues as you, knowing that they might have resolutions to or plans of attack you can use (D5)

In secondary focus groups, the issue of teacher reluctance to share was perceived as a greater issue than was the case in primary focus groups, where the culture of sharing appears to be more widely accepted.

What happens in schools is an issue still I... there are some faculties that would have closed door – I keep my bit with me and it's almost like personal property (J7)

If you are talking about group sharing between schools two things come into it, modesty and humility – in front of the kids we have plenty of bravado, in front of our colleagues there is a whole hesitation about it. (L2)

The theme of time was constant throughout all focus groups, particularly when discussing teacher contribution to a knowledge site.

I would be interested in it but it's really just allocating the time for it (A9)

It all comes down to time and priorities (E6)

Participants identified the need for a balance between regular and expert contributors. Expert contribution was identified as relevant to provide knowledge (as opposed to classroom application) and to contributions in areas outside of the expertise of classroom teachers.

Several participants who were regular participants in on-line forums also saw a role for expert moderators:

... (you) need people who are really knowledgeable – a lot of forums have a leader, a moderator, a person that comes in and throws in questions and leads things ... otherwise a forum can just become a question with no replies (I2)

6.4 Review of Literature to Determine the Significance of the Problem

The results of phase 1 indicated that teachers had current, well-established links for the sourcing of learning and teaching materials, and that the level of satisfaction in what was currently available through external sites was high. The significant benefit of developing a diocesan knowledge site was the ability for such a site to link teachers of the diocese directly to each other. Teachers believed that it would enable the exchange of information and ideas between schools, particularly among teachers of the same stage or teaching the same key learning area.

Teachers claimed that there would be value in developing repository items and sharing units of work, particularly when repository items were meeting specific diocesan standards, as opposed to generic, externally-sourced information. It was also clear from the focus groups that teachers valued the exchange of teacher know-how and wisdom of peers, and sought ways to connect with other teachers through the

Internet.

The original intention of phase 2 was to involve teacher focus groups in the assessment of their preferred on-line format for learning materials from both a user and a contributor perspective. The findings from phase 1 identified a need for teachers to connect with each other through more expansive networks. As a result, the focus of phase 2 was broadened to incorporate a more specific user-evaluation of sites designed for teacher learning: in particular those who used Web-2.0 technologies to “empower learners to create personalized and community-based collaborative environments ... (enabling) learners to weave their human networks through active connections to understand what we know and we want to know” (Tu, Blocher & Roberts, 2008, 253). The expanded focus incorporated an assessment of ways in which teachers respond to social networking as a tool for professional use, and included the response of users to Web-2.0 “social networking” sites and use of “social software” as a tool to connect with other teachers.

Several studies examined the use of Web-2.0 for educators and concentrated on individual teacher use, or on individual tools such as blogs, wikis, social networks, tagging systems, mash-ups, and content-sharing sites (Plus, 2008; O’Connell, 2008; Way, 2008; Cress & Kimmerle, 2007). The focus of phase 2 was to ascertain how these elements could be combined to support teacher learning, and to derive from this process the first design principles for a teacher knowledge-management system. There is limited academic literature in relation to the deliberate use of Web-2.0 technology for knowledge-sharing across a system, and most studies report a shortfall between the potential of such systems and what is actually delivered. For example, West, Wright, Gabbitas and Graham (2006) conducted a case study on the use of Rich Site

Summary (RSS) feed with a group of pre-service teachers and found limited adoption due to high levels of student confusion and frustration. Glotzbach, Mohler and Radwan (2007) similarly found students hesitant to adopt the new technology. Schlager, Fusco, Farooq, Schank and Dwyer (2009) in analyzing social networks on Tapped-In were unable to determine whether meaningful ties were occurring between individuals. Whilst it is clear that Web-2.0 technology has the potential to “bring people together in a more dynamic interactive space” (Barsky & Purdon, 2006), there remain critical questions with respect to application in a defined community of teachers within an education system such as the Catholic Education System.

In phase 1 few of the teachers were users of networking sites for educators, and no teacher in the focus groups was familiar with educational networking sites such as Tapped-in or EDNA. This indicated an immediate dis-connect between the stated desire for greater teacher networking and the actual practice of the teachers. This will be a critical element to understand in the development of an effective knowledge-management system, as this element will ultimately distinguish a repository-style system and an active and organic system that supports deeper learning.

6.5 Identification of Practical Problem and Research Questions for Phase 2

Phase 1 of the research established that practitioners wanted a knowledge-management system that enabled them to share with colleagues. Current practices for on-line knowledge management and retrieval were described and practitioners stated inadequacies of the existing *Myclasses* platform. For example, practitioners described their existing practices that involved accessing materials from the web. These descriptions did not generally include materials made by themselves or colleagues or

sharing resources among work colleagues at different locations. Nor did they describe on-line practices of co-creation, reflective processes regarding the value of materials, nor sharing of practice as opposed to accessing of content. Phase 2 , described in Chapter 7, engaged practitioners in the development of design principles that would underpin the building of a prototype that would support these latter practices, and provide a platform for teachers, meeting their stated need for on-line connection. To determine the preliminary design principles, Phase 2 engaged practitioners in an examination of existing external sites for teacher knowledge sharing and learning to determine:

1. Usability aspects of the sites that teachers support;
2. Functionality that supports teacher knowledge sharing;
3. The frameworks used for peer and expert contribution and the response of users; and
4. Impact on knowledge representation on user experience.

From this process, the initial design criteria for a knowledge-sharing system for teachers was developed.

7 PHASE 2 - DEVELOPMENT OF SOLUTION INFORMED BY EXISTING DESIGN PRINCIPLES

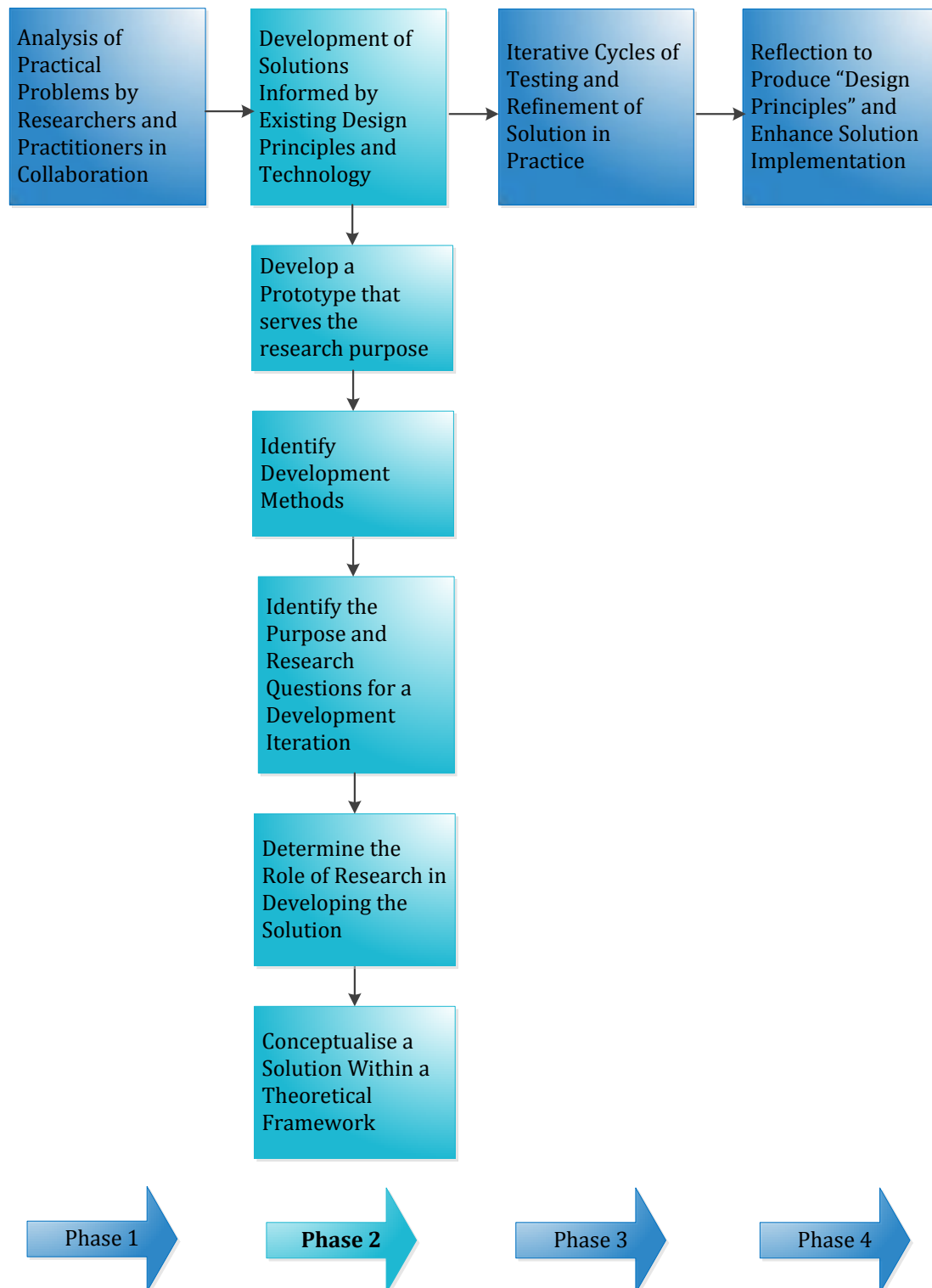


Figure 11: Design Research Phases adopted from Ma & Harmon, 2009: Phase 2 Steps Described

7.1 Introduction

This chapter builds on the work of phase 1. The results of that phase indicated that:

1. Poor usability of *MyClasses* contributed to its failure to achieve acceptance among teachers, and the lack of user adoption of all of its available features;
2. Teachers indicated that a knowledge-management system designed to support teacher professional learning would be useful, and supported the development of a prototype; and
3. Teachers wanted a prototype that connected individual teachers with professional colleagues through social-media tools.

The diagram above outlines the phase 2 process to develop preliminary design principles for a prototype of a knowledge-management system. The development model adopted in this phase was the Technology Acceptance Model (TAM), described below. This phase did not involve the development of the proto-type as a review of literature identified that there were no existing design principles in the field of knowledge management. Therefore the main research question considered in this phase was whether general heuristics for usability as developed by Nielson (1994) were applicable to a knowledge-management system, or whether, consistent with the experience of other on-line processes such as gaming, retail and adaptive learning environments, specific and unique heuristics would apply.

To explore this issue, semi-structured group interviews with practitioners were conducted. The interviews focused on the analysis of existing on-line environments

used by teachers. Referred to as evaluators, the Phase 2 practitioners were invited to complete specified tasks (INTRAC, 4) as the method for evaluating the effectiveness of these sites to support teacher on-line knowledge sharing practices. Tasks included the uploading and downloading of files, the location of specific information and access to social media forums linked to the sites (appendix C).

Evaluator responses were analysed against usability criteria and a heuristic framework specific for an on-line knowledge-management system was developed. The conceptual solution developed then informed the first prototype, designed and tested in phase 3.

7.2 Conceptualise a Solution within a Theoretical Framework

The Technology Acceptance Model (TAM) is a framework for understanding adoption and use of information technology (IT) solutions (Venkatesh, Morris, Davis & Davis, 2003; Venkatesh & Bala, 2008; Gross, 2005). This model is used to predict individual adoption of new IT solutions, and states that the intention to use new IT is defined by the **perceived usefulness** (the extent to which a person believes that the new IT will enhance their job) and **perceived ease of use** of the solution. The relationship among perceived usefulness, ease of use, and attitude toward using new technology is represented in the diagram below. This model predicts that a positive attitude towards using new technology will translate into actual system use.

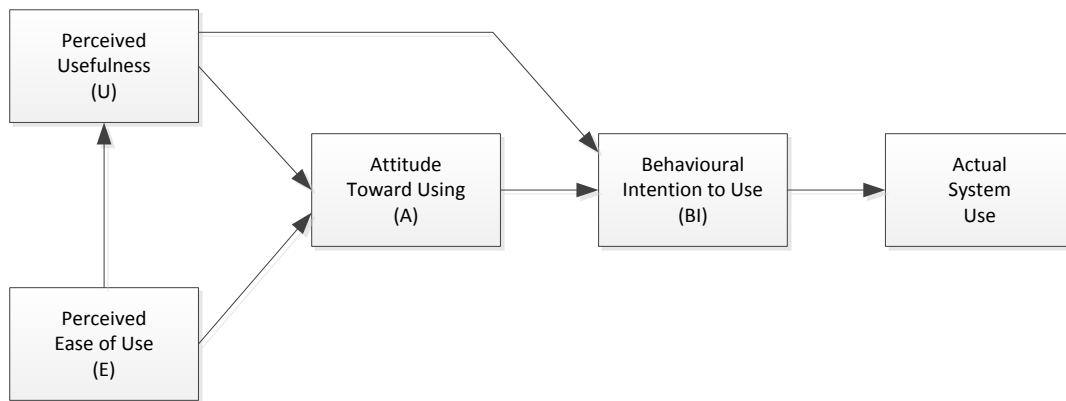


Figure 12: Technology Acceptance Model (TAM)

Phase 2 specifically examines **perceived ease of use** in order to develop preliminary design principles for the prototype.

Described in chapter 5 (Methodology), this phase involved the analysis of a range of education and non-education sites by three user/evaluator groups to identify criteria that contributed to ease of use from the perspective of teacher knowledge sharing. Shroff, Deneen and Ng (2011) reported that the perceived ease of use has a significant impact on attitude to perceived usefulness. This is consistent with the experience of teachers with *MyClasses* who were highly critical of its usability.

The **perceived usefulness** of each site reviewed was considered but other related factors, such as: image (Moore & Benbasat, 1991); job relevance (Venkatesh & Davis, 2000); and output quality (Venkatesh & Davies, 2000), were not specifically examined. However, relevant comments by user evaluators have been captured in the conclusion to this chapter.

Individual differences such as personality and/or demographics (straits of individuals, gender and age) can influence perceptions of perceived usefulness and ease of use (Vankatesh & Bala, 2008). However Vankatesh (2000) states that

perceptions regarding ease of use directly relate to the individual's general beliefs regarding computers and computer use, and specifically the attributes regarding computer self-efficacy, computer anxiety and computer playfulness. The user/evaluator group were therefore asked to self-identify their level of computer proficiency. This is captured in the table below:

User Group	Primary group 1 (P1-P6)	Primary group 2 (P7-P12)	Secondary group (S1-S6)
Complete Novice	1	0	
Recent Adoptor	4	2	
Average (somewhat confident) user but identifying as still having a lot to learn	0	4	2
Confident User	1	0	4

Table 9: User Group Demographics

Participants who described themselves as recent adopters included three primary teachers who were currently enrolled in a system-delivered professional development program, Technology for Learning. Recent adopters reported being “barely a step ahead of the children” (P1); “relying on students and a work colleague to assist” (P3), and “still having a lot to learn” (P8). Recent adopters reported that they mainly used software applications such as Microsoft Word and PowerPoint, and basic web searching primarily for sites that supported units of work.

Participants who described themselves as having average user ability reported that they used the Internet to access information, video clips, images and web sites for all different aspects, and were able to troubleshoot reasonably effectively. These users spoke about incorporating technology into the classroom, integration with learning and teaching and using it to assist in meeting student outcomes.

None of the participating teachers reported that they currently used the Internet to support their own professional growth and learning.

There is a body of research related to usability of web interfaces. Nielsen (1994) developed criteria that provide a useful basis for evaluating functionality of web sites. These criteria or heuristics have been applied in subsequent studies in the areas of e-commerce, gaming and e-learning. Zhang and Dran (2000) conclude:

- some factors identified are more useful than others depending on context;
- in some contexts factors other than those identified by Nielsen (1994b) are required; and
- it is unclear whether addressing the factors is sufficient to make users satisfied with using the web site).

Designing for one purpose may actually impair the design for another (Spool, Jared, Scanton, Schroeder, Snyder & De Angelo, 1999). Thus the purpose of the prototype defines the type of tasks that the prototype needs to be able to perform and the functionality required for ease of use. However, Nielsen's heuristics have been criticised as being too "product oriented" (Floyd, 1997; Muller, Matheson, Page & Gallup, 1998; Hoffman & Novak, 1996; Chen & Macredie, 2005).

Table 10 outlines Nielsen's (1994) heuristics for web-based design and compares these to heuristics developed in studies into the areas of adaptive learning environments, on-line retail and gaming. Evident from these studies is the manner in which the heuristic framework is applied and modified for the specific purpose. Additional and unique heuristics applicable in each of the applications have been captured in the second part of table 10.

These studies identify the need to examine heuristics from a process perspective, keeping in mind the purpose of the site and the way in which users approach and interface with the site. It is important to note, that even when features are directly matched to Nielsen's heuristics, the form and function that is applied is in direct response to the purpose of the site. Therefore the application of the heuristics to an online knowledge-management system will have unique characteristics that require development through a collaborative process during this phase of the research design.

	Traditional Usability Criteria (Nielsen, 1994)	Adaptive Learning Environment (Magoulas, Chen & Papanikolau, 2003; Reeves et al. 2002)	Commerce (On-Line Shopping) Wolfingbarger and Gilly (2000); Bouch, Kuchinsky and Bhatti (2000)	Gaming Federoff (2002); Desurvire and Wilberg (2009)
User Experience		Support for a continuum of learning modes from system- controlled to full learner- controlled.	Design features are required to increase user sense of control and freedom. Service quality important.	
	1.Visibility of System Status – user is informed about what is going on	Learner is informed through appropriate feedback in reasonable time.	Users know where they are and options available	Score and/or level information is available.
	2.Match Between the System and the Real World – System uses user’s language and real- world conventions	Words, phrases and concepts are familiar to the learner (Reeves et al.) Information matches individual’s learning preference (Magoulas et al.)	Inputs are meaningful	Interface metaphors help players understand how to navigate through an environment.
	3.User Control and Freedom – User can select and sequence tasks	Learner can recover from input mistakes (Reeves et al.) Learner can develop personal strategies, and change learning modules.(Magoulas et al.)	Users can go back and forth between multiple menus.	User is able to control movements of the characters and how they explore the environment.
	4.Consistency and Standards – consistency in	General software conventions are	Page layouts are consistent	Interfaces should be

	words, actions and objects.	followed (Reeves et al.) Adaptive behaviour does not change learning model (Magoulas et al.).		consistent throughout
	5.Error Prevention – careful design eliminates errors.	Common problems are prevented. Adaptation decisions support learners to avoid errors (Magoulas et al.).	Fields in data entry screens contain defaults information where appropriate.	Not directly relevant. Warning messages that assist user in making less grievous errors.
	6.Recognition rather than recall – actions, objects and options are visible. Instructions visible and clear.	The user does not have to remember information when moving from one part of the program to another (Reeves et al.). Instructions and cues help learners identify adaptation results (Magoulas et al.).	All data the user needs is displayed at each step.	Instructions should be retrievable throughout the game.
	7.Flexibility and efficiency of use – operations allow for different users.	The system accommodates learner's preference by providing alternative ways to gain access to information (Magoulas et al.).	Partially filled screens can be saved.	Playable by players of all different skill levels.
	8.Aesthetic and minimalist design – no irrelevant information.	There is no irrelevant information (Reeves et al.). Minimalist and aesthetical design (Magoulas et al.).	Only essential information is displayed on the screen.	Controls should be simple and non-intrusive.

	9.Help users recognise, diagnose and recover from errors – error messages clear and in plain language.		The help section is complete, clear and understandable.	
	10.Help documentation – information is easy to find and sets out clear steps related to the task.	Help and documentation are easily accessible (Reeves et al.). Searchable help functions and documentation (Magoulas et al.).	The help section is complete, clear and understandable.	Help available through a tutorial.
Additional heuristics				
		Interactivity – interactions and tasks support meaningful learning.	Support and extend user's current skill.	Game interface – controls are intuitive and mapped in a natural way.
		Message Design – information is presented with sound information processing principles.	Pleasurable and respectful interaction with the user.	Game mechanics – mechanics should feel natural and have correct weight and momentum.
		Learning Design – program reflects sound principles of learning theory.	Protect personal information.	Game play – create a good storyline, visual and audio affects arouse interest, teach skills early that are used later in game, design for multiple paths through game.
		Media integration – inclusion of media serves sound pedagogical		

		purpose.		
		Instructional assessment – assessment is aligned to objectives and content.		
		Resources – resources necessary for effective learning are provided.		

Table 10: Demonstration of the Way in which Web Site Purpose Influences the Applicable Heuristics

Phase 2 adopts a process-oriented approach. Through the involvement of teachers it develops the heuristics and usability guidelines for the creation of an on-line management system for teachers. Results are analysed to interpret the application of Nielsen's heuristics in the context of knowledge management and to identify whether additional heuristics are required.

Evaluators were not provided with a pre-determined set of heuristics as the purpose of phase 2 was to analyse the user's experience to determine applicable heuristics for a knowledge management system and to develop priorities informed by the relative importance of the different criteria. Thus, phase 2 is not a traditional heuristic evaluation, which would involve "a small set of evaluators (who) examine the interface and judge its compliance with recognised principles (the heuristics)" (Nielsen, 1994).

Following the analysis, a further step was undertaken to confirm or refute the heuristics prior to their incorporation as design criteria. This involved testing of each item against relevant theories and models.

The first part of the evaluation was a free-flow exploration inspection (Chen & Macreadie, 2005, 521). During this step, user evaluators were invited to inspect the site under evaluation. This allowed a general perception to be developed. The second part focused on specific elements of the site, and was developed through task-based inspection, in which users were provided with a series of tasks that they were asked to undertake in relation to each of the sites. These tasks represented the types of activities that had been identified in phase 1 as relevant to the way in which users envisage use of a knowledge-management system (appendix C). The experience of

the user/evaluator with each site was then recorded as each individual responded to questions that reflected criteria identified in phase 1.

These questions follow:

- How do users of this site create, edit, share and organise their learning and how would you see the same morphology applying to teachers within the diocese?
- To what extent does this site integrate or limit the learning opportunities offered by Web-2.0 technology?
- What social arrangements are supported by this site, and what are the implications for a prototype?
- How does this site meet teacher needs for privacy, and the issues of trust and intellectual property?
- What features of this site facilitate learning within context?
- How does this site assess the effectiveness of materials?

Selection of Sites:

The sites that were evaluated during phase 2 were identified from the phase 1 focus group, with the exception of Tappedin, identified by the researcher during the literature review, and Edublogs developed by the researcher to determine whether the format in which materials were presented influenced user intentions to either contribute or re-use materials. Sites that were evaluated were:

Scribd – <http://www.scribd.com>

EDNA – <http://www.edna.au>

BEST – <http://www.bestedsites.com>

TappedIn – <http://tappedin.org>

Teacher Tube – <http://teachertube.com>

EDUBLOGS – <http://www.edublogs.org>

Twitter – <http://twitter.com>

Analysis of phase 2 falls into three parts:

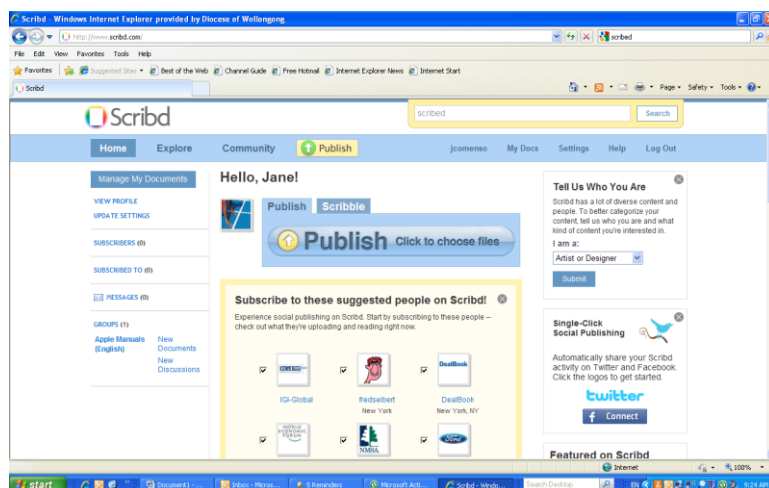
1. Feedback regarding each of the sites;
2. An analysis of the heuristics required for a prototype knowledge-management system based on the strengths and weaknesses identified through the evaluation; and
3. Evaluation of literature to determine whether the proposed heuristics can be externally validated through relevant theories and models.

In the concluding section of this chapter, the outcomes of phase 2 and the literature review are used to develop preliminary design principles for the prototype.

7.2.1 Feedback Regarding Each Site

Scribd:

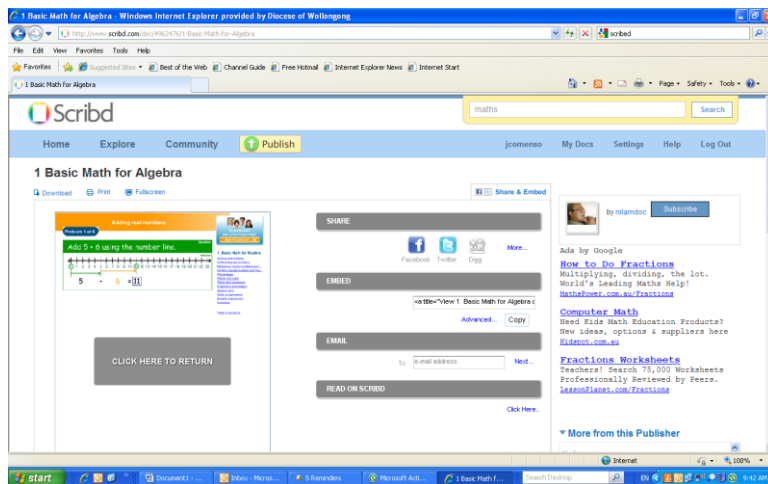
Scribd is described as a social publishing site that allows people to share original writings and documents. Whilst not specifically directed to an education audience, its documents are organized into categories, including presentations, puzzles/games, schoolwork and spreadsheets. It states, “On *Scribd*, you can easily turn any file—such as PDF, Word and PowerPoint—into a web document and immediately connect with passionate readers and information-seekers on our thriving community”. The screenshot below captures the home-page of a scribd member, and demonstrates clearly the link between site functionality and the page design with the “publish” tool clearly visible to users.



Consistent with the purpose of the site, participants found it extremely easy to upload and share material on *Scribd*.

Participants, including novice users, were able to upload to the site in just two steps. First, by selecting the “publish” icon and then by selecting from their own computer the document they wished to share. The publishing process was experienced as intuitive and not

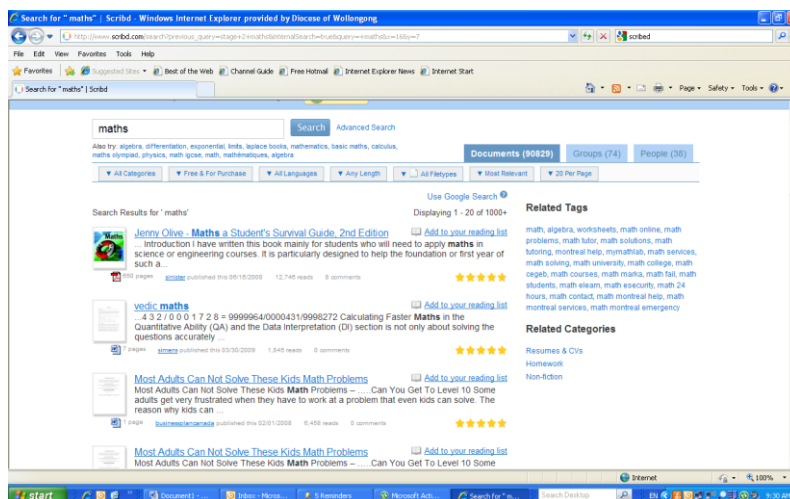
requiring specialist expertise. Documents were transferred without changing the format or the features and embedded material retained formatting on transfer.



Participants were also positive about the ease with which material could be used. Visible in the top right hand corner of this page is the menu that allows selected

documents to be easily downloaded and printed , and users to easily “share”

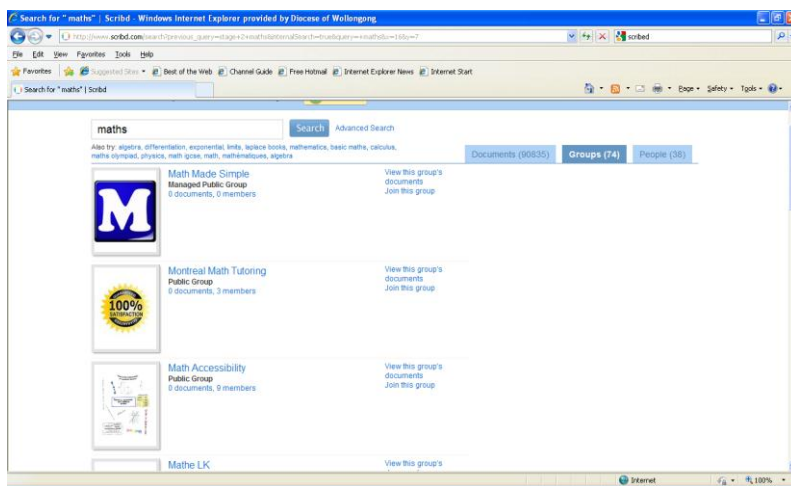
(forwarding to colleagues) and “embed” (inserting content into other materials and documents) thereby allowing content to be easily e-mailed to colleagues, embedded in documents, bookmarked and referenced on social networking sites. The top toolbar was seen as quite critical and very useful and user friendly.



With regard to the ease of use of documents, participants found useful the full title that was provided, the indicator of the size of

the document, the descriptors regarding content of each document and the rating (star) scale. These are shown in the screenshot above. Several participants commented that

they would prefer to read a comment to judge usefulness of the contribution (P5)(S3) and (S6). A rating system such as this was seen as helpful in terms of encouraging use and contribution, but the fact that the stars used by Scribd had no attribution (beyond being a one-to-five scale) detracted from its usefulness. Participants expressed the view that any such scale should be linked to comments on how useful the user found the contribution, as this was seen as being non-judgmental - “just because you don’t like it doesn’t mean that it won’t work for someone else” (S2)



From the perspective of users being able to form smaller communities of interest, participants were attracted to being able to see at a glance the number of members

in a group, and the number of documents associated with the group. For example, the Math Made Simple Group, shown in the screenshot above, has five members only and no documents. This was seen as a quick and easy way to judge potential usefulness, with participants demonstrating interest in those groups with high levels of membership and documents available. This site also allowed groups to be established as “open” or password protected, and teachers saw this as an effective way for them to retain some control over how their materials would be shared, used and disseminated.

Whilst users were able to search using a number of criteria, for example the number of pages, file type, most relevant and most recent, the search function

remained the major drawback to usability of the site. This limited ability to easily locate materials was seen as a major drawback: “Given the nature of teaching we have such short periods of time to do our research, and in that time we expect to find what we want pretty quickly” (ST1), “The hits that came up weren’t useless but close to it” (ST3) and “It was very difficult to find ... information from this site. You find yourself starting off with a very general search, not finding what you are after, so then you become more and more specific. Again the results were very limited to what I was after” (P10).

The fact that sharing was limited to written documents and did not include video upload capacity was seen by a number of teachers as a negative.

Participants also commented negatively on the “busyness” of the site, the distraction of advertisements, the use of “related” tags which cluttered the visible area, poor search functionality, poor organization of groups, limitations in the usability of discussion features and limitations regarding the type of material that could be shared, i.e. documents and presentations only.

The strength of this site was seen as its functionality in allowing publishing, downloading and sharing of documents. The design was such that these critical functions were intuitive, and did not require any prior computer knowledge or specialist expertise.

Education Network Australia (EDNA)

EDNA describes itself as a network of the education and training community. It includes government and non-government schooling systems, early childhood,

vocational and technical education, adult and community education and higher education. *EDNA* is a site specifically designed for Australian teachers.

EDNA was viewed positively by participants – ‘it was quick and there was lots of useful information (P8), “It had professional reading as well as resources that could be used in the classroom, it had both” (P12). Specific aspects of the home page design were valued including “news”, topical issues, recently-added resources and the bottom left icon pointing to significant days (at the time of the focus groups “Walk to School Day” and “World Diabetes Day” were featured). This ensured relevance and currency to the target group, and, “Little things like the events list for in-servicing or meetings make life easier” (P5).



The visual layout of the site, as illustrated in the screenshot, was the first observation of participants. It was described as

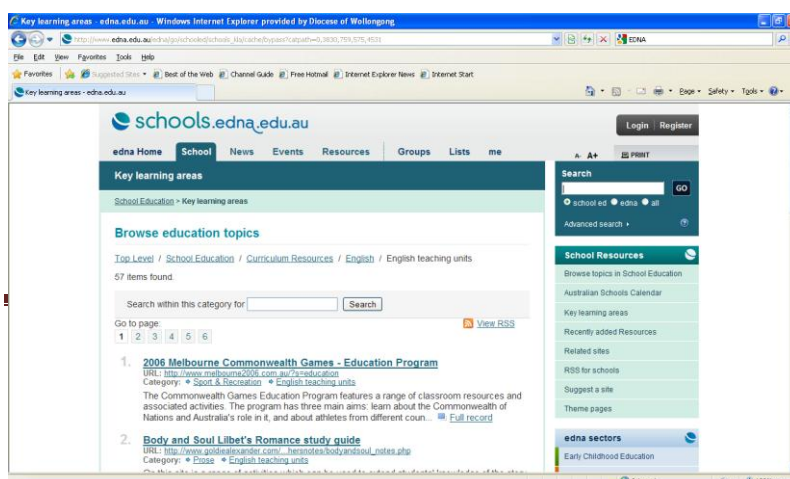
appealing, “ It is not as busy, even the photos make it nice to look at” (P1); “I like the way it is set out” (P2). The blue and white colour scheme was seen as very clear, “you want to use it, you feel comfortable to use it and going and having a look at it” (P4).



Functionally this site was seen as user friendly. Participants referred to the clarity of the tool bar and the ease of navigation

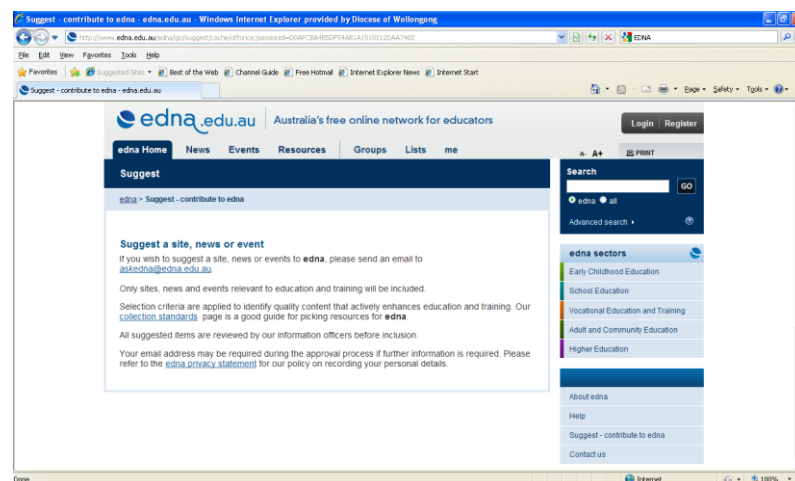
between sections. In particular, this site made clever use of colour to differentiate the different educational sectors. This assisted the site navigation, as the blue and white scheme anchored participants to the home page, and then school resources were divided into early childhood, primary and secondary, each with their own unique colour scheme. The teal and white screen shown above designated the primary school site. Participants commented “I liked the way they organised it under different colours and different headings so that you can clearly see if you were where you wanted to be” (S5); “The colour of each section meant you know where you are and you don’t have to worry about having to sift through information that might not be relevant to you” (P10).

The search function was effective and users found it easy and fast to locate what they were looking for. Options were available for standard, advanced and distributed searches, the latter type connecting to outside websites such as the ABC and government agencies.



However, some users found the information not sufficiently

specific to be useful. This screen shot illustrates the way in which information was categorised by topics rather than in broad areas, and it was not clear as to the nature of the resource that was being linked: “I would like something where I could get more categories. It was too broad ... and I would like to know what age group it is, otherwise you have to go in and look and it might be totally irrelevant” (P6); “there is too much information to sift through” (S3). Some users also found frustrating the fact that topics were linked to web-sites as opposed to documents that could be used directly and adapted (S2), (S3). Participants (P9) found *EDNA* quite difficult; “I had to do a lot of sifting through web sites just to get one that is remotely useful”. Like *Scribd*, *EDNA* allowed for a range of formats to be posted including video and podcasts; “I typed in “smartboards” and it brought up a you-tube page demonstrating it – it was brought up the clip straight away regarding how to do something specific on the smartboard and I liked that” (P1).



Users could not make direct contribution to *EDNA* unless through a group, and as illustrated in the screen shot, individual

submissions were directed through a link to a mediating group for assessment prior to being posted. In general contributions to topics, materials or web-links could only be made through the administrator. This was seen as an advantage by only two participants, one of whom (P3) thought that if no-one knew what a teacher had suggested, it made it very private, and the other who believed that intervention by the

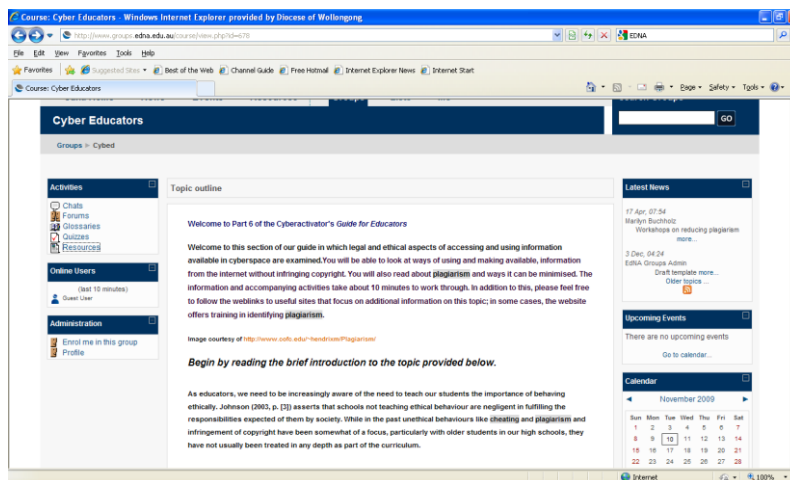
administrator was an effective way to maintain the quality of what was posted on the site (P5). However there was no facility within *EDNA* to “judge” quickly the usefulness of contributions, and a number of participants believed such a feature would have enhanced the usefulness of the site.

The focus group participants were positive about the features within *EDNA* groups that allowed teachers to connect with each other, share resources such as documents with each other and e-mail or chat around a topic. “ There is an area you can go and see pod casts that different people have put up – you don’t have to have i-tunes or a specific program.” (P9)

There were very clear instructions, stepping users through how to set up and participate in a group. One teacher who classified herself as an “IT Novice” said that she would need this step-by-step approach. However many of the groups were private and had locks. Some groups allowed guest visits. The locked access was seen as a barrier both to accessing and contributing, “inclusive/exclusive ... don’t have time” (S2); “I didn’t like it ... you need a key, what is the point?”(S4); “If I want to share my resources, it is not easy to join a group, get on a forum, ask a question”(S3). Only two users (P5) and (P8) saw the locked forums as a positive, as a means of building trust between contributing colleagues. Generally it was viewed as inhibiting the free flow of information.

The use of icons within the resource link allowed users to determine immediately the category of information they were accessing. Users were positive about the opportunity provided for on-line networking through chat. There was some concern at the number of groups represented (P3), that some of the groups were too

narrow (P5), and that having to search for groups (P6) was awkward and a suggestion by several users that ordered groupings, such as by KLA, might be helpful in making



the site more useable.

A negative of the site was that sharing of files did not appear to be easy. The type of file was not readily

apparent and “It ... should have a little picture icon similar to *Scribd* that shows what sort of document that you might be downloading. Without it, it was a waste of time”(S3).

BEST

Site created and owned by Janice Berthiaume, MED

Last Updated July 9, 2009

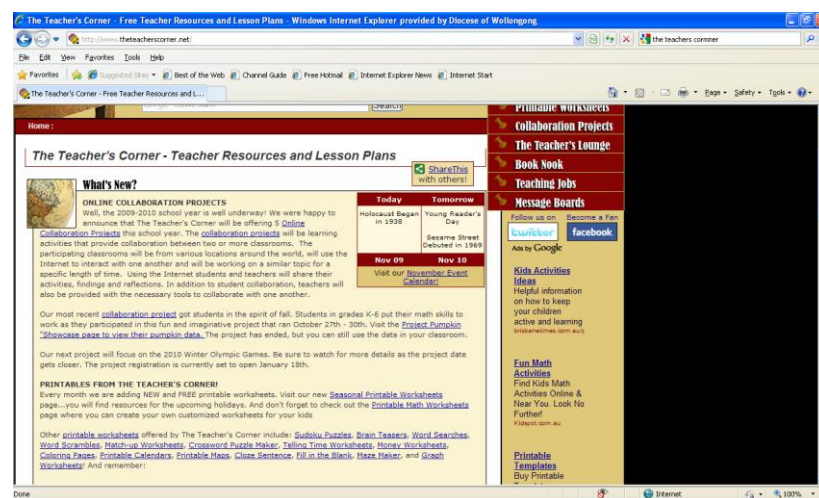


Directed to primary teachers, this site was seen as being poorly planned and without cohesion. “It is quite random at times and

very in-depth ... if you were trying to find something it would be very easy to get lost” (PT8).

The lack of order and planning of the site reduced its effectiveness for teachers despite the fact that the repository material was seen as useful by several of the focus group participants (PT3,5,6). Whilst materials were usable and reproducible, there was no provision for sharing information and its only use as a repository was as a source for worksheets and stencils. Users within the focus groups were frustrated that there was no information provided until each link was opened.

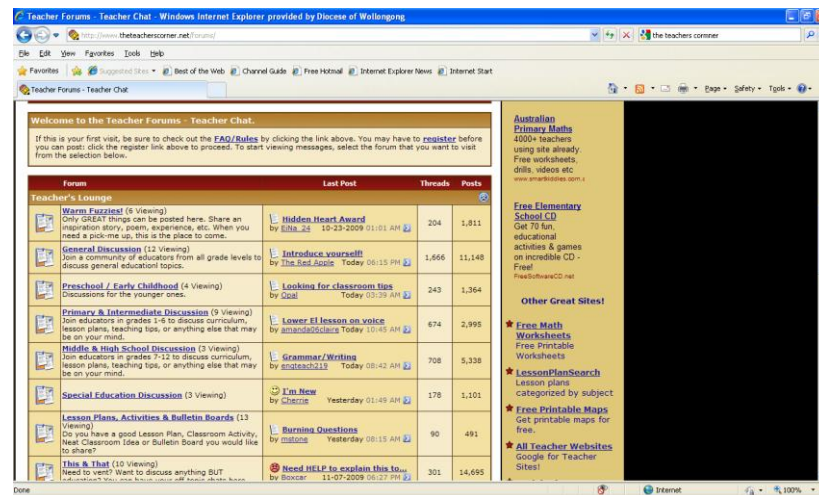
The Teachers Corner



Focus group 1 also evaluated *The Teachers Corner*, which was accessed through a link on BEST. As illustrated in the screenshot,

this site was visually cluttered and therefore users reported it as not being as easy to use as the *EDNA* site. Whilst users were able to submit material to the administrator via e-mail, it did not allow direct access by teachers to being able to submit materials or remove them at a later date. Most resources were links to web sites as opposed to documents, and again users found this was too time-consuming to facilitate regular use. For example, the lesson plan link in the top menu directed users to web sites such as *lessonplanet* (www.lessonplanet.com) from which documents could be downloaded (at a fee). Users were frustrated that it was not evident which were the free links and which were commercial. *lessonplanet* was described by participants in

focus group 1 as having features that would encourage teacher use, including title of the lesson plan, description, review, target age group and rating.



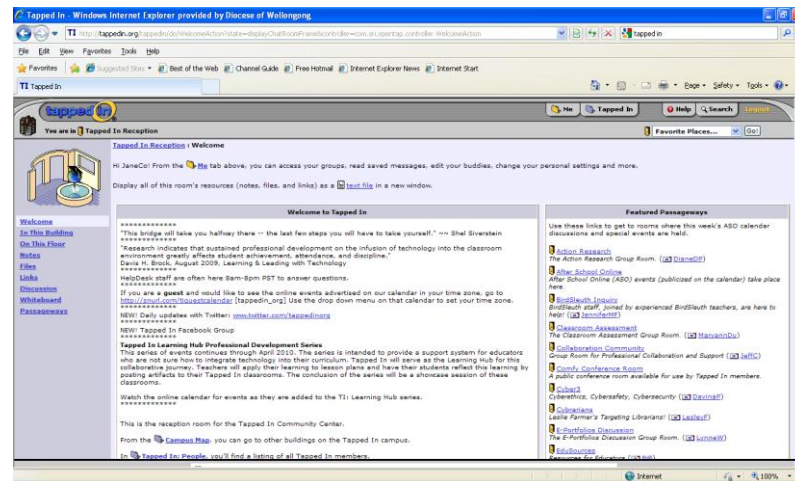
The teacher forum within Teachers Corner was seen as providing a lot of opportunity for teacher-sharing and discussion. Viewing

by target group, threads, last postings and the number of replies were all seen as effective overview tools, and the forum had a search function to enable easy access to past discussion threads. Four teachers from focus group 1 expressed some concern that the tone of some chats was social, not professional, and saw this as potentially limiting that value to teachers – “I just don’t have time for that”, “it is a risk, this type of conversing”.

Tapped-In

Tapped-In is an online “workplace of an international community of education professionals. K-12 teachers, librarians, administrators, and professional development staff, as well as university faculty, students, and researchers gather here to learn, collaborate, share, and support one another.” It has 2,800 members worldwide. As illustrated in the screenshot below, the screens were visually dense with a lot of material on each screen.

User reaction to *Tapped-In* was very negative and demonstrated the importance of navigation and structure of information to usability of a site.

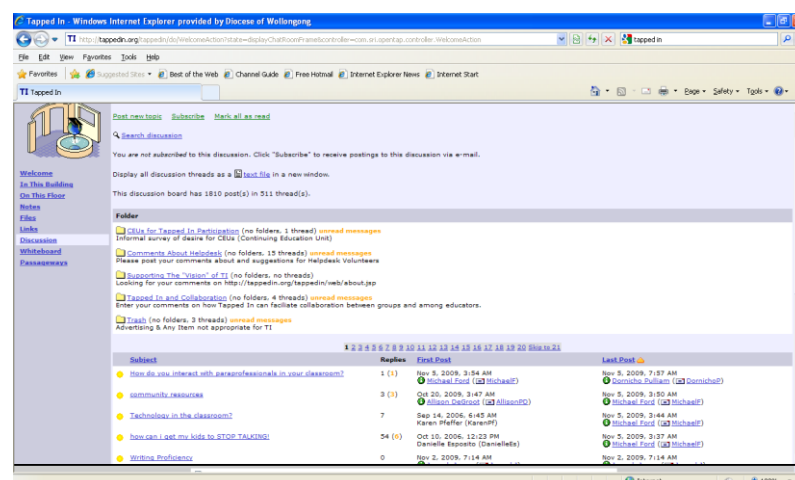


“I found the site really hard to navigate” (P1);

“It is overwhelming” (P4); “There is just so much information there” (P6); “I

couldn’t get into the ideas for teachers” (P8); “I can’t wait to get off this site – it is just too much and I don’t even like the font” (S3); “As a novice user this is something I would not go near” (P6).

Conceptually, *Tapped-In* was seen as quite difficult. Participants had difficulty understanding how to store files, access and create links, and plan or conduct learning projects. Editing and sharing was complex and non-intuitive (P8). Many of the “rooms” were empty or not populated by information. This was a source of frustration for users who would follow an interesting title/source but would find nothing at the end of the process.



The on-line discussion facility provided within *Tapped-In* was seen to have several positive features,

including dates of the first and last post, the number of replies and ability to search for a particular discussion thread. However a number of participants found it difficult to find the particular discussion area for which they had had an interest (P5), (P6), and one had no success in accessing any discussion at all (S2).

Users believed that their use could be enhanced if they were able to nominate particular areas of interest and be notified when threads regarding that area were initiated. The quality of the discussion threads was variable with no governing of the contributions: “some threads someone would ask a question and the replies would just be people saying hello to each other” (P7). (P9) expressed the view “In a diocesan forum I would expect someone to tap in and say “that’s not appropriate”.

Significant discussion took place regarding the log-in protocols and whether discussion contributors should use their real names. Whilst one primary teacher (P6) believed anonymity would provide more honesty, the majority of teachers in the focus group believed it was important to maintain professional profiles including the teacher’s name, years of experience, areas of expertise, workplace and e-mail contact. However, there was also a view expressed by three of the primary teachers that similarly to the social networking site *Facebook*, individuals should be able to choose to respond in a private or public forum.

Teacher Tube

Use of video was seen as having the potential to support teacher professional learning and growth. “I remember something we were shown on Wikis and no amount of explaining would have made me understand as much as the clip ... did”.
(P4)

However, rather than necessarily creating and uploading their own materials, teachers preferred to use this site for existing links to specific video clips and the central creation of new materials that covered teacher-identified areas for professional development such as how to conduct a guided reading lesson or enquiry-based learning, both of which were system priorities at the time of the conduct of this phase of the research. “I would learn more from a video clip in one minute than reading a page” (P3); “I would be more likely to look at something than read (P5)”; “Lessons could be filmed with a teacher de-brief about what worked and what didn’t work (P4)”; The theme that video was “much easier to understand” was repeated across the three focus groups.

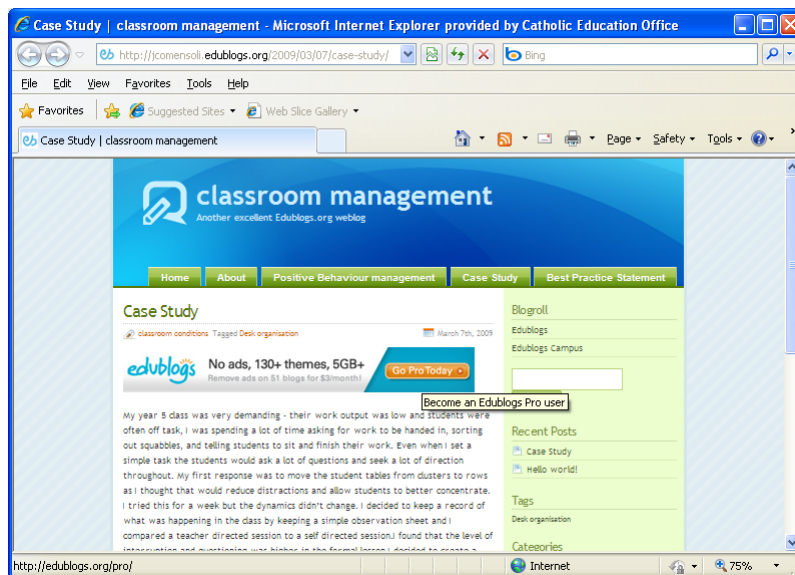
The website was seen as user friendly with clear icons and menus. Users found this site easy to navigate. The search function was effective.

This site was the only site specifically mentioned as having broader applicability to parents with one user (P7) seeing potential “for small 1-minute lessons for parents to help at home”. However, the site was seen primarily as a way for teachers to share material as opposed to collaboration for learning. Two users (P8 and P9) had accessed the site previously but had not understood that forums were available until this was pointed out within the focus group.

When evaluating previous sites, participants advised that a rating system would enhance usability, but for this site a rating system was viewed as irrelevant “as everyone has different opinions”(S3) and “ it is unclear who actually watched it”(P1).

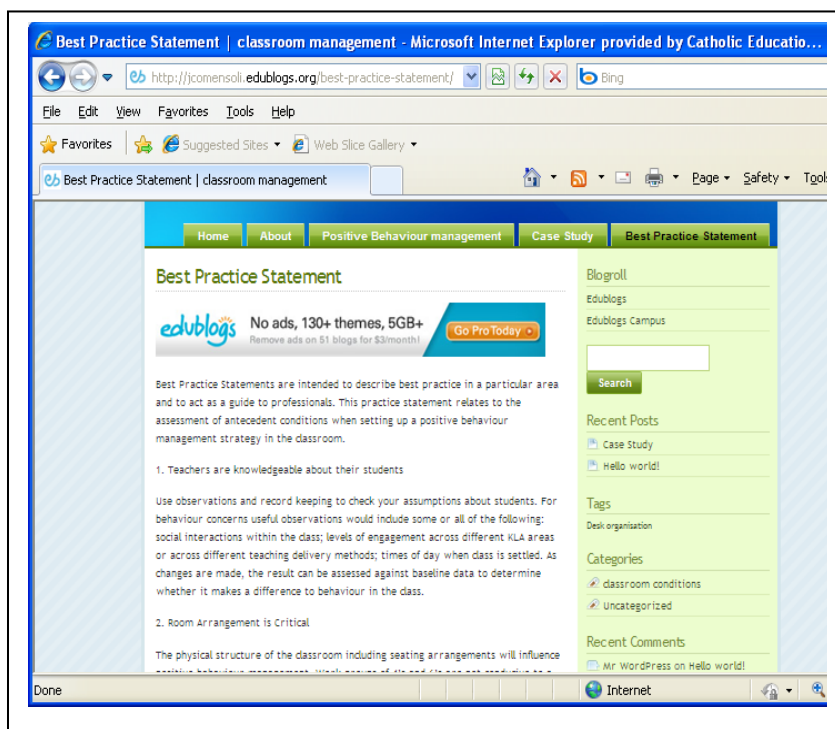
Edublogs:

Edeblogs is a site specifically designed for teacher and student blogs. It has the capacity to include videos, photos and podcasts. The researcher used edublogs to ascertain whether the form of teacher-knowledge captured could be seen as influencing teacher learning.



The same information regarding a teacher account of classroom management issues was set-up using the alternative formats of a best-practice statement, and case

study. The full content of each screen is available in appendix 7. The case scaffolding was informed by the work of Schulman (1996), and followed the morphology of a case study: 1. the scenario including context, intention and plan; 2. what happened – what actually happened, including unanticipated problems and difficulties; and 3. what was learned – action that was taken to relieve the difficulties and how the resolution led the teacher to a different level of understanding than before. The best-practice statement on the other hand was loosely-based on the work of (reference) in which nursing best-practice statements were used as a form of on-going nurse professional development and as a way to create consistency in nurse practices.



With regards to the narrative style, all teachers in the two primary teacher focus groups favoured the narrative style of presentation: “I like narratives, it is my learning

style” (P3); “It prompts reflection” (P5); “It links in with things” (P2); “I was automatically thinking about the seating arrangement in the classroom” (P1); “I learn better by case study ... it is more open-ended” (P4); and “I think there is so much evidence that children need meaning and context to learn ... so I think the same would apply to us in our learning” (P6).

Teachers in focus group 2 repeated this theme: “I read the case study – first it looked a bit full-on and the second one looked better ... but the case study was a lot better, I could see what was really happening” (P8); “I preferred the case study – it was easy to read, structured and precise” (P9). One user (P12) described the case study experience as similar to going to a teacher for advice

However there was caution from the secondary teacher group: “I struggle to get through 40+ e-mails per day ... it’s easier to just have a few sentences” (S4); “This is static, not quick and easy”(S2).

Twitter

The first focus group did not engage in Twitter and could not see any value in it as a tool for teacher learning, despite the facilitator providing some context of its use as a “personal learning network” by some educators.

Within focus group 2, there were two participants (P8, P9) who had previously used Twitter. In principle there was not support for use of Twitter, as it was thought that having an RSS feed to a person on Twitter removed the entire advantage of being able to network as it focused in on linking an individual to others whose work was already known.

The secondary teacher focus group was similarly cautious stating that the school day is too busy to be checking “twitters” and e-mail would work just as effectively for professional exchanges.

7.3 Heuristics of a Knowledge Management System

An analysis of the user/evaluator feedback is summarized in the table below. The table is based on Nielsen's heuristics and provides an explanation, based on the user's experience, of how these heuristics translate into design when the purpose of the site is for knowledge-management for teachers. Design features identified by users as strengths for a teacher knowledge-management system are identified together with those features that failed to meet the heuristics requirements. Additional heuristics unique to an on-line knowledge-management system were identified, and these also are captured in the table below:

	Traditional Usability Criteria (Nielsen, 1994)	Strengths – for a knowledge-management system	Weaknesses – for a knowledge-management system
User Experience		The ability to upload and download materials is critical to the user experience, as is the ease with which connection and interaction with colleagues can occur.	

	1.Visibility of System Status – user is informed about what is going on.	Colour coding as used in EDNA allowed users to clearly select options.	Users unable to identify site location (Tapped-in and BEST).
	2.Match Between the System and the Real World – system uses user’s language and real world conventions.	The language used is education-focused. The language used by SCRIBD assisted task completion. Organisation of materials matches the structures used in education i.e. subject areas and stage of learning (EDNA).	Organisation that does not reflect age groups or subject areas. Language doesn’t match morphology used by teachers (Tapped-in).
	3.User Control and Freedom – user can select and sequence tasks.	The ability to move backwards and forwards. Ease of sharing of materials (SCRIBD). Good search function (EDNA).	Poor searchability of objects (SCRIBD).
	4.Consistency and Standards – consistency in words, actions and objects.	EDNA was clear and consistent throughout the site.	Tapped-in was confusing as different formats were used throughout different sections of the site.
	5.Error Prevention – careful design	Data input.	Important options did not always have

	eliminates errors.		prominence.
	6.Recognition rather than recall – actions, objects and options are visible. Instructions visible and clear.	The same colour is used to group different elements (EDNA).	Prompts and messages were not located in a convenient position.
	7.Flexibility and efficiency of use – operations allow for different users.	SCRIBD was well-designed for user ability ranging from novice to expert.	There were not different levels of detail to support novice and expert users.
	8.Aesthetic and minimalist design – no irrelevant information.	Each screen has a short, clear and distinctive title (EDNA).	Extraneous information on the screen – clutter and additional tags (SCRIBD, BEST, Teachers Corner).
	9.Help users recognise, diagnose and recover from errors – error messages clear and in plain language.	The help screen is complete, accurate and understandable.	It is difficult to switch between the help function and the work.
	10.Help documentation – information is easy to find and sets out clear steps related to the	Clear instructions provided on how to set-up groups (EDNA).	Lack of direction and assistance (Tapped-in).

	task.		
Additional heuristics	Pleasurable interaction with the user.	Site is relevant and current to the user, and visual layout is inviting (EDNA).	Too much colour and excessive icon design and movement (BEST).
	De-Privatisation.	Easy access to groups. Contributors named and contactable.	Password functions required to access forums, locked access.
	Interactivity – interactions and tasks support meaningful learning.	Users are able to connect with colleagues in a variety of ways, including through special interest groups, synchronous and a-synchronous chats. File sharing is easy. Information provided regarding dates of posts.	Groups are closed (Tapped-in) or overly specific (EDNA). Users unable to directly load contributions (EDNA, BEST) without going through an administrator.
	Message Design – information is presented with sound information processing principles.	Use of icons to categorise information.	
	Learning focus.	Users identify themselves by name, location and contact (email) to enable further	Chats and discussion threads are social and not professional (Teachers Corner).

		questions and contact to be made.	
	Media integration – inclusion of media serves sound pedagogical purpose.	Clips support areas for teacher professional development.	
	Resources – resources necessary for effective learning are provided.	Description of the resource provided including size, type, and content of the material. An indicator from other users of the usefulness of the document (SCRIBD).	Resources that are links as opposed to documents (EDNA, Teachers Corner).
	IT agnostic.	Usable on multiple devices. No specific programs required to access materials.	Special programs required to open or access materials.

Table 11: Analysis of Sites in relation to Nielsen (1994) Design Heuristics and Identification of Additional Heuristics Required for an On-line Knowledge-Management System

7.4 Validation of Heuristics Through Literature Review

It is evident that tools for on-line knowledge management need first and foremost to follow good web-design principles. Users articulated the same principles as had been identified by Nielsen (1994) thus supporting the application of general web-design heuristics to sites that support teacher knowledge-sharing. The need for teachers to connect with colleagues requires additional heuristics that apply specifically to that context. In general, EDNA and SCRIBD performed strongly against the Nielsen heuristics, but less favourably against the additional criteria identified for on-line teacher collaboration. Tapped-In, Teachers Corner and BEST performed poorly and would not be used by any teacher in the focus groups regardless of their content because of their poor design. These sites were reported as chaotic and failed to meet criterion 4, consistency and standards. Criterion 4 was not otherwise identified by evaluators, nor were criteria 5, error prevention, and criteria 9/10, help assistance and documentation specifically mentioned. This does not mean that these criteria have less significance for the prototype development, but would more likely have been evident over a longer period of use or through an expert heuristic evaluation.

From the focus groups it was evident that criterion 7, the flexibility of use to support novice as well as expert users, is particularly important as the teachers' focus group reflected the demographics of the general teacher population that consists of both expert users and novices. To accommodate this diversity the site must be simple to read and easy to navigate. The heuristics are described below, and were derived from literature and chosen for application to a website intended to support knowledge management and teacher learning.

Visibility of system status

This criterion relates to the ability of the user to identify where they are on the site at any particular time and the provision of feedback to the user in a reasonable time. A way-finding system similarly incorporates branding, signs and directional devices that tell us where we are, where we want to go and how to get there (Wyman, 2009). Whilst the concept of way-finding is generally used to describe images used for public planning, Wyman (2009) describes how the use of symbols can be used in web-design to incorporate and make simpler “maps and directional devices”, to denote symbols that give information and direction to people in a clear, appropriate and friendly way. It provides clues or inferential information to the user (Tan & Wei, 2006).

Darken and Silbert (1993) discuss the importance of way-finding in large virtual worlds and examine the way in which subjects use environmental cues to complete complex searching tasks. Whilst the study is focused on gaming and therefore is literal in its reference to maps, landmarks and districts, there are aspects that are identified in the gaming environment which may be transferable to other on-line applications, and particularly those that have similarly high levels of complexity such as a knowledge-management system. These are:

- i. Spatial knowledge – the ability to conceptualise the space as a whole
- ii. Environmental Design – a recognizable location or region of a larger space that allows users to identify where they are located.

Colour was used effectively in a number of the interfaces to conceptualise the learning space either by task or by target group. Effective colour schemes, such as

those in EDNA and Edublogs, were simple and applied throughout the site in a uniform manner. EDNA used colour as an organizing and differentiating factor and teachers commented positively on the way it allowed them to know where they were on the site and to navigate quickly to areas of interest. Vogt, Kumrow and Kazlauskas (2009) discuss the effective use of colour in web-design. Colour coding can be used in the instructional process to assist the user to focus on essential learning cues. Keyes (1993) theorized that the use of colour is effective as it decreases the learner's cognitive load. Because colour is perceived automatically, less cognitive processing effort is required, and therefore it can be used effectively to organise and classify information, enabling readers to process more information effectively. However, as was evident with sites such as BEST, the indiscriminate use of colour can cause confusion, and increase difficulty and reader effort (Keyes, 1993, 646). With EDNA, it was clear that the use of specific colour to differentiate sections of the site became quickly associated with meaning to the teachers. This approach was used by Brusilovsky, Schwartz and Weber (1997) to support student navigation through course material.

Use of way-finding aids is particularly important for “naïve” searches i.e. those in which the navigator has no prior knowledge of where to locate what they are searching for. Darken and Silbert (1993) conclude that on-line gaming environments, and therefore by implication, possible other complex on-line environments, require that: 1. the organizational elements should be organised according to a visible organizational principle, 2. should allow the users always to know their position, and 3. should orientate the map. The experiments conducted in the way-finding research

were focused primarily on navigational skills applied to an on-line environment and the application of the principles more generally is untested.

Match between the system and the real world

Marcus et al. (1996) postulate that when information is incorporated into an automated schema, the working memory will be minimal and the information (instruction) easier to understand. The presence or absence of appropriate schemas impacts on cognitive load. It was evident from the focus groups that the schema in which teachers were most comfortable to organize the material was that which followed the language and organization of the curriculum documents they were required to use. Participants' preferred schema was, at the highest level, the curriculum of the NSW Board of Studies, in which information is organized by stages (stages is an ordering construct used by education authorities to denote the learning continuum of students. In NSW it defines learning outcomes for students from early stage 1, and stages 1-6).

Teachers then looked for sub-levels, by key learning area or outcomes within each stage. The focus group evidence is that teachers used this schema whether they were accessing repository materials or discussion threads and the like, using WEB 2 technology.

User control and freedom

Participants valued highly the image buttons used by *Scribd* and *EDNA*. On *Scribd*, active icon buttons such as “upload” and “publish” were large and visible and supported the key activity of the site, which was to upload or download documents. These buttons acted as direct navigation cursors, and encoded routes that allowed

users intuitively to gain access to, and use, information rather than being required to have particular computer knowledge to navigate menus and applications. On *EDNA*, the icons served a different purpose and pictorially denoted the types of resource – namely chat, forum, and resource. Other devices that participants valued were the inclusion of descriptors with web-links and materials, thereby enabling some assessment of potential use of a link or material without having to access it directly. Given that one of the common barriers teachers in phase 1 cited for failure to access knowledge-sharing sites was time, the high importance placed by phase 2 teachers on the use of symbols, descriptors and shortcuts can be understood. These features also contributed to *Scribd* being one of the sites more positively evaluated by novice users, and relate also to criterion 7, flexibility and efficiency of use.

Korper & Ellis (2000) describe typical web users as being browsers, i.e. they flip from page to page, scanning material, and will not wait too long for pages to download or for images to be displayed. The speed of download was significant in this study, with participants leaving slow web sites. As this is directly related to file size, image, sound and video files need to minimize their file size. This same “scanning” behavior occurred when accessing social media sites, with users becoming impatient if their search failed to deliver relevant material immediately. It was also evident from phase 2 that whereas much of the social interaction of the web took place in small communities of interest, participants could not always readily identify which community would contain material relevant to their problem or query. Much of the criticism of sites such as *Scribd* and *EDNA* was that searches failed to discriminate information sufficiently and delivered outputs that were broader than the user required.

Recognition rather than recall

A common theme throughout the focus groups was the desire of participants to understand quickly the material that was being presented. Marcus et al. (1996) postulate that two factors influence the ease of understanding – the intrinsic complexity of the information, and the manner in which the material is presented. In the research conducted by Marcus et al. (1996) the focus was on the way in which diagrams, labeling and text could be used to design material to reduce working cognitive load and to enhance long-term memory (Chandler & Sweller, 1991). The critical determinant of information to enhance these characteristics is the degree to which it can be processed individually, without reference to other elements or whether the material has elements that must be processed simultaneously within working memory (Marcus et al., 1996). When elements interact, cognitive load is reduced if an association or link can be made with schema held in the long-term memory. Successful use of this concept was demonstrated in the *Scribd* and *EDNA* sites, in which icons and short descriptors were used to convey information effectively to users regarding the type and content of materials. These icons linked to prior experience of users by either referencing prior computer experience (in the case of document types, download sizes, etc), or to their prior working experience by referencing key words or concepts that were recognized as being useful to the problem at hand. Rating “stars” were also used effectively on a number of sites, reducing the cognitive load required to determine whether a source was likely to be helpful. This facilitated decision-making – either to access the material or to investigate usefulness further by reading comments of other users.

Aesthetic and minimalist design

EDNA was particularly strong in organising information clearly, providing clear icons and titles, and using white space effectively. Vogt et al. (2009) state the importance of white space as allowing the eyes to rest. The BEST site demonstrated how colour and movement could become distracting and irritating to the learner. Keyes (1993) stressed the importance of typography and colour as means of decreasing the time and effort required to access, comprehend and use information.

The response of participants to the layout of materials also reflects the importance of the intrinsic nature of the material. In the focus groups there was little support for text-only sites, as they were viewed as too cluttered, and too time-consuming and requiring too much effort to understand and comprehend. Participants looked for organizing structures such as titles, key findings and clear diagrams to enable content to be easily read and understood. Whilst phase 2 of this research did not specifically evaluate the impact of text vs diagram, text and illustration should be used together to be effective (Mayer, 1993; Chandler & Sweller, 1991). These findings have implications for the way in which repository materials are presented, and ways in which teachers are encouraged to create materials for a knowledge-sharing site. Visual and verbal information have been shown to be held in the respective visual and verbal memories concurrently, therefore it is important that “the chunks of information are small enough not to overload the learner’s working memory” (Voght, Kumrow & Kazlauskas, 2001, p47). Only material that is relevant and important (Winn 1993) should be incorporated so as to reduce information redundancy. Visual or verbal redundancy is an aspect of cognitive load theory research. It has demonstrated that pictures and narration that are presented with

redundant text impeded learning due to the increased cognitive load on the visual working memory (Moreno & Mayer, 1999; Mousavi et al., 1995).

The reaction of the focus group to the web layout suggests that regard must be had to the typography and the spatial context of the information (e.g. participants were deterred from using sites found to be too “busy”). General principles for layout need to be considered and adopted. Keyes (1993) suggests that horizontal and vertical spacing should be used deliberately and specifically, with the vertical spacing defining the information zones on the page and the horizontal spacing defining hierarchical levels such as topic chunks and sub-chunks. Vertical positions are noticed first and therefore identify key elements of the information structure. The spatial divisions should be cued visually through use of contrast. There is a cognitive limit to the amount of visual cuing that can be absorbed, and colour can extend this limit by creating a visual layer.

The reaction of participants to sites such as BEST, the Teachers Corner and Tapped-In is explained in part by poor design and overload of the threshold for typographic cueing. Keyes (p.644) states, “visual complexity becomes perceptual overload and leads to decreased performance. The eye jumps distractedly over the page, the cues lose their distinctiveness ... complexity and effort outweigh benefit”.

7.5 New Heuristics

As discussed earlier, users identified additional heuristics that were required for the development of an on-line knowledge-management system. This is consistent with studies referred-to earlier in the areas of e-commerce, gaming and retail, in which unique heuristics are derived from the on-line process that the technology is

required to support. Those identified for a knowledge-management system are described below.

De-privatisation

There is an inherent tension in the creation of the knowledge-management system between the intent to create “open” systems that encourage contribution across an entire system of teachers, and the tendency to create smaller communities of practice or communities of interest. This was evident in the manner in which participants interacted with the selected sites, moving quickly from general information to searching for information, threads or groups that reflected their own particular area of interest, e.g. boys’ education group. The usage of the sites suggest that teacher identity is less focused on the generic role of teacher than on their individual practice and focus for individual learning at a particular time. This suggests that within a knowledge-management site the collective learning process for teachers requires some capacity to enable teachers to form groups or, as described by Wenger et al. (2002), domains of knowledge in areas of specific professional interest. It is these community domains that Wenger et al. (2002) suggest create the shared learning agenda that motivates individuals to contribute to the practice of that community. However, as the focus of professional interest will change from time to time depending on the professional challenges of the teacher, easy entry into different groups or community is required. Participants became frustrated when entry into smaller communities on the targeted sites was locked and access denied.

Site design must also ensure that the pre-defined nature of groups does not preclude cross-disciplinary learning and application. The importance of good search capability, discussed in the technical section below, is an important feature that

supports cross-disciplinary learning and “opens” the information held within groups to individuals.

Phase 1 of the research clearly identified the potential benefit for a teacher knowledge-management site as being the opportunity to create connections beyond a teacher’s own school or sphere of colleagues. It was also seen as beneficial if, having seen ideas or information from an unknown peer, there was the possibility to make direct contact. Trust became an issue that phase 1 participants discussed openly, particularly in the context of whether teachers would be more likely to contribute posts and materials if their contribution was anonymous.

Participants in phase 2 had opportunity to use a variety of sites, some of which had contributors using their own name and details, and others that allowed the use of avatars. Users were of the view largely that contributions should be made with identification of the contributor. This was seen as a matter of professionalism, and of ensuring transparency in interactions, “you should have your own name as we are professionals – in terms of giving support and receiving support your own name is good enough” (P7); “Professionally it is important for people to state who they are” (P10). It was also seen as a positive way in which the standard of contributions would informally self-monitor, as individuals would be less likely to make inappropriate remarks or to make poor quality contributions. However, it should be noted that a small number of focus group participants was of the view that anonymity would ensure more honest contributions.

Media integration

Web technology offers the opportunity to combine text, image, and sound with the ability to be static or inter-active. The relationship between audio and visual is particularly important given the desire by teachers to use video, podcasts and text, illustration and sound capability, as tools to enhance their professional learning. Multi media should use small amounts of information in visual and audio mode rather than large amounts of either.

Learning focus

As discussed in previous chapters, a knowledge-management system must be capable of engaging teachers in knowledge-sharing to support teacher-learning, knowledge and practice. This requires more than a depositary, and requires an on-line environment capable of supporting authentic learning. The characteristics expected to be valued by users, based on the work of Herrington and Oliver (2000), would: be an opportunity to promote authentic contexts; be based on authentic, real-world experiences; provide access to different perspectives including expert opinion and modeling; support collaboration; promote reflection; and provide a framework within which tacit knowledge would be made explicit.

In phase 2, sites that were recognized by participants as providing an authentic learning environment for teachers included *TeacherTube*, *EDNA* and *Edublogs*. This authenticity was created in three distinct ways: through sites having the ability to upload videos which demonstrate the physical environment that reflect real situations; through the use of the case-study format (refer to the Edublog entries); and through the use of synchronous and asynchronous discussion threads, in which those discussions scaffold learning rather than simply providing socially-oriented commentary.

The knowledge-management system must be constructed to enable individual learning to occur, that is learning “oriented towards changes in individual knowledge structures” (Lipponen et al., 2004, 35; Bereiter, 2002). Information should not be de-contextualised or objectified. Context-rich contributions support knowledge-sharing. Wherever possible, contributions will include authentic context with “rich situational affordance” (Young & McNeese, 1993). The classroom management case study used on the *edublog* site, and sites such as EDNA that incorporated teacher video, were seen as effective by most participants as they created the conditions described by Lordly (2007), in which understanding of information is increased through personalisation, increased critical thinking skills and the creation of context through which meaning and connection are established. Herrington & Oliver (2000, 28) refer to video clips as “drawing on the characteristics of a situated learning environment”. When feasible, the video clips should cover teachers demonstrating strategy, comments on the strategy, assessment technique and expert “theoretical perspectives”. These can be supplemented with work samples of teachers and students.

Use of scenarios and other context-rich sources, whether text-based or multi-media, must however be balanced with the requirements regarding cognitive load. Participants are clear that they will not seek access to materials that are lengthy and complex, and in the case of video or podcast, have lengthy download or play time.

Interactivity – interaction supports meaningful learning

Whilst teachers in phase 1 expressed the desire to communicate with other teachers through forums, etc. (i.e. blogs, postings and chat), the users in phase 2 did not have a positive experience regarding such tools. Many of the chats that were examined were of a social nature and did not add to the professional practice of the

user. Whipp (2003) examined the issue of scaffolding for reflection in electronic discussions about field experiences and found that without explicit support for critical thinking, users would offer emotional support rather than challenge each other's thinking about their experiences. In developing a site for teacher knowledge-sharing that goes beyond a repository or social support model, it is important for contributions to be scaffolded in a way that encourages dialogue reflection, including the capacity to challenge assumptions and ask further questions.

There are various forms that scaffolding can take, ranging from: mediation and facilitation; use of a recognized expert in the area under discussion; giving teachers access to expert thinking and modeling processes (Collins, Brown and Newman, 1989); moderators for discussion threads within wikis; and formal structuring of contributions by way of case study or practice statements. There is evidence that contributions by a moderator to discussion threads are a useful adjunct to teacher postings. The moderator can use tailored questions to encourage reflection-on-action, and to encourage different perspectives on topics from various points of view, the latter being a characteristic of situated learning (Bransford, Sherwood, et.al., 1990; Brown et.al., 1989; Lave & Wenger, 1991).

Focus group participants clearly valued the role of moderators in ensuring that discussion forums maintained learning as opposed to social focus. The role of the moderator is diverse. Rather than a passive role of simply moderating "out of order contributions", the moderator can play an active role in supporting the learning and development of the contributors. In particular the moderator may see a general theme or "Follow discussion boards and see what is emerging" (P8), and encourage contributors to reflect on their experience and practice. Moderators can also "link with

professional articles” (P9), encouraging participants to explore other roles and perspectives. The moderator can also model strategies and scenarios and provide alternate views. It should be noted however that the use of a moderator in itself provides an independent perspective, so long as participants do not become reliant on the third party intervention against their own reflective practice and professional reading.

There is also some evidence that the structuring of **user responses** can facilitate learning (Hatton & Smith, 1995). Users can be encouraged to respond to unstructured postings by using framework for reflection that includes posing general questions on critical issues and incidents, and observational and support-based contributions (Hatton & Smith, 1995).

Whilst the functionality for social networking is critical to a knowledge-management site, the phase 2 participant experience demonstrated that the structure of interactive forums is highly critical of the usability of the site. Without clear structure, users can find the information overloading and have difficulty in utilizing posts, etc, for the purposes of their own learning. Several approaches to the structure of forums were seen as enhancing usability. These are reflected in the design principles below.

IT agnostic

Use of the targeted sites identified some critical consideration regarding how the sharing of information could be supported. These ranged from the ability to upload/download without the need for specialised software, to providing intuitive design so that novices could easily access the full functionality provided by the site.

7.6 Conclusion:

Phase 2 has identified general usability criteria, based on Nielsen's heuristics, modified for an on-line knowledge-management context. These are summarized below:

	Traditional Usability Criteria (Nielsen, 1994)	Strengths – for a knowledge management system
User Experience		The ability to upload and download materials is critical to the user experience, as is the ease with which connection and interaction with colleagues can occur.
	1.Visibility of System Status – user is informed about what is going on.	Design elements such as colour coding act as navigation cues. Information is clearly available regarding user-initiated actions such as uploads and downloads and status of materials. Related materials are located together and easily searchable.
	2.Match Between the System and the Real World – system uses user's language and real-world conventions.	The language used is educationally focused and reflects phrases and concepts that teachers use in their day-to-day environments. Organisation of materials matches the structures used in education, i.e. subject areas and stage of learning. Symbols, icons and names are intuitive within the context of the task. Information is arranged in a logical order.
	3.User Control and Freedom – user can select and sequence tasks.	The ability to move backwards and forwards between repository and social functionality is supported. Sharing of materials is logical and straightforward.
	4.Consistency and Standards – consistency in words, actions and	The site is clear and consistent. The same concepts and words are used

	objects.	throughout to refer to the same thing.
	5.Error Prevention – careful design eliminates errors.	Data input is simple and straightforward.
	6.Recognition rather than recall – actions, objects and options are visible. Instructions visible and clear.	The same colour is used to group different elements, groupings of elements follow a logic that teachers use in their day-to-day work.
	7.Flexibility and efficiency of use – operations allow for different users.	The design caters for user ability ranging from novice to expert.
	8.Aesthetic and minimalist design – no irrelevant information.	Each screen has a short, clear and distinctive title. Use of spacing, colour, white space and typography provide a pleasurable interface experience to users.
	9.Help users recognise, diagnose and recover from errors – error messages clear and in plain language.	The help screen is complete, accurate and understandable.
	10.Help documentation – information is easy to find and sets out steps related clearly to the task.	Clear instructions provided on how to set up groups and discussions.
Additional heuristics		
	De-privatisation	Easy access to groups. Contributors named and contactable.
	Interactivity – interactions and tasks support meaningful learning.	Users are able to connect with colleagues in a variety of ways, including through special interest groups, synchronous and asynchronous chats. File sharing is easy. Information provided regarding dates of posts.
	Message Design – information is presented with sound information processing principles	Use of icons to categorise information.
	Learning focus	Users identify themselves by name, location and contact (email) to enable further questions and contact to be made. Scenarios are professionally located (not social) and are relevant to the professional practice of teachers.

	Media integration – inclusion of media serves sound pedagogical purpose.	Clips support areas for teacher professional development.
	Resources – resources necessary for effective learning are provided.	Description of the resource provided, including size, type, and content of the material. An indicator from other users of the usefulness of the document is provided. Materials contain a sense of the context in which the resource was created and used.
	IT agnostic	Usable on multiple devices No specific programs required to access materials.

Table 12: Heuristics for a Knowledge-Management System

As discussed in the introduction, this research phase was directed to identifying the design principles for an on-line knowledge management system. Analysis of evaluator feedback supports the proposition of Igbaria et.al. (1997), that user unfriendly systems create resistance and a perception that the site is not useful. The prototype must therefore meet ease of use criteria that have been identified before any analysis of usefulness can be undertaken.

Provided that the system meets sufficient ease of use criteria and does not alienate the user, then the perception of usefulness would be predicted to be more important than ease of use in the context of teacher knowledge sharing. This is based on the Phase 1 feedback relating to teacher constraints regarding time and opportunity and therefore the assumption that these constraints may be countered if the value of use outweighs the constraints. Therefore determinants identified by Venkatesh & Davis (2000) such as job relevance, the degree to which such a system will be applicable to the role, the match between job goals and system use, and results of using the system may be essential to the adoption of the prototype.

Chapter 8 describes Phase 3, the development, testing and refinement of the prototype. The design heuristics developed in Phase 2 informed the initial prototype. It would be expected, following analysis of literature and evaluator outcomes, that successive design iterations of Phase 3 would enhance the usefulness of the prototype. The heuristic framework discussed and developed in this phase will therefore continue to be used as an evaluative tool throughout the Phase 3 design and analysis.

8 ITERATIVE CYCLES OF TESTING AND REFINEMENT OF SOLUTIONS

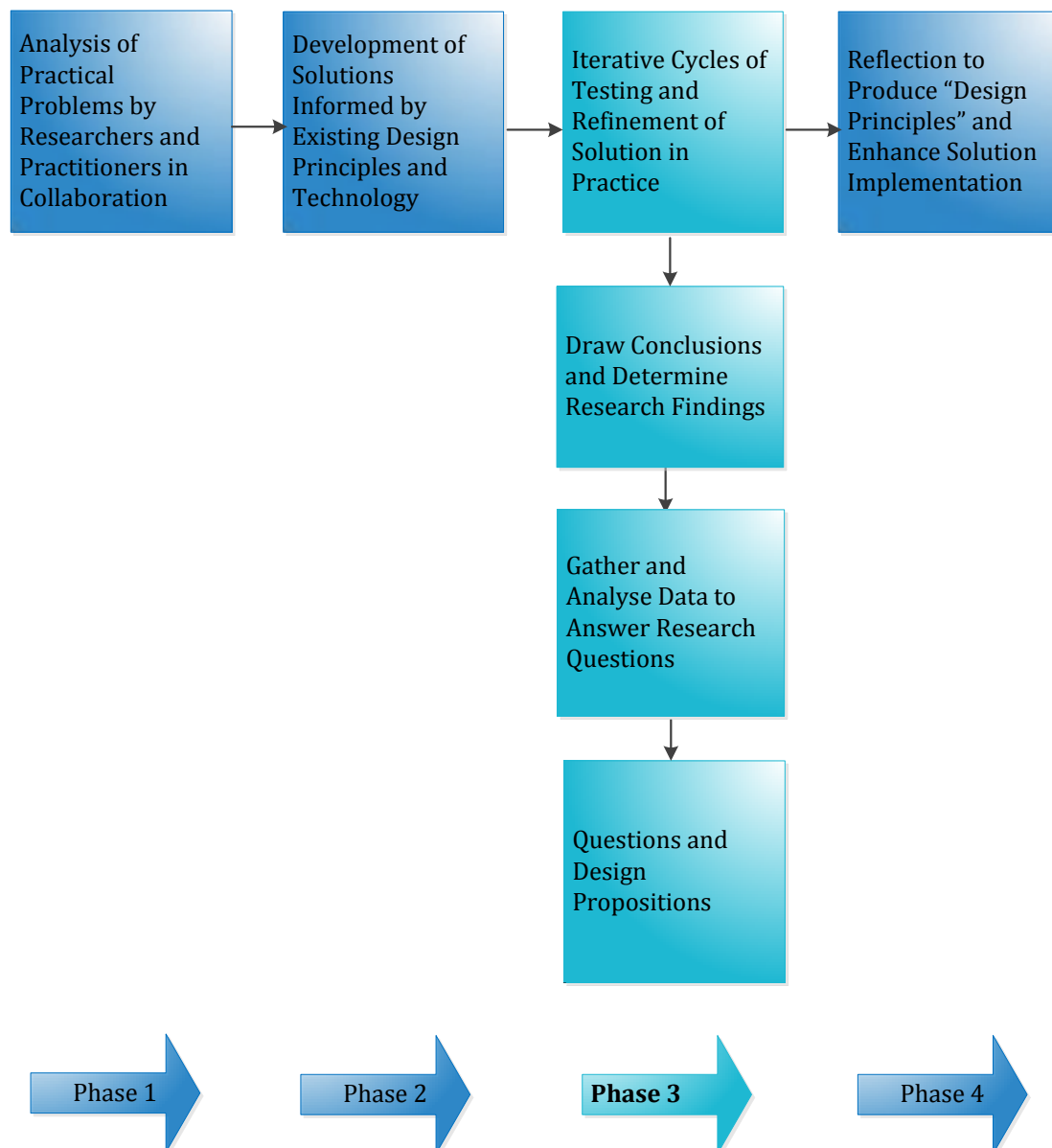


Figure 13: Design Research Phases adopted from Ma & Harmon, 2009: Phase 3 Steps Described

8.1 Introduction

This Chapter describes Phase 3 of the research. The diagram above outlines the critical steps of Phase 3, which is focused on the development, testing and refinement of the problem, solutions, methods and design principles (Reeves, 2006, 59). As discussed in chapters 4 and 5, a prototype approach was adopted (Ma & Harmon, 2009). The first iteration of the prototype was based on the preliminary design principles determined in phase 2 of the research (reported in chapter 7). These principles focused primarily on *ease of use* heuristics. Phase 3 provided a further means of evaluating the applicability of these principles as well as determining *perceptions of usefulness* that would inform the development of additional design principles.

Design principles adopted during the prototype development are summarised in the table below:

Design Criteria for Ease of Use (Usability)	Description
	The ability to upload and download materials is critical to the user experience, as is the ease with which connection and interaction with colleagues can occur.
1.Visibility of System Status – user is informed about what is going on.	Design elements such as colour coding act as navigation cues. Information is clearly available regarding user-initiated actions such as uploads and downloads and status of materials. Related materials

	are located together and easily searchable.
2.Match Between the System and the Real World – system uses user’s language and real-world conventions.	The language used is educationally-focused and reflects phrases and concepts that teachers use in their day-to-day environment. Organisation of materials matches the structures used in education i.e. subject areas and stages of learning. Symbols, icons and names are intuitive within the context of the task. Information is arranged in a logical order.
3.User Control and Freedom – user can select and sequence tasks.	The ability to move backwards and forwards between repository and social functionality is supported. Sharing of materials is logical and straightforward.
4.Consistency and Standards – consistency in words, actions and objects.	The site is clear and consistent. The same concepts and words are used throughout to refer to the same thing.
5.Error Prevention – careful design eliminates errors.	Data input is simple and straightforward.
6.Recognition Rather than Recall – actions, objects and options are visible. Instructions are visible and clear.	The same colour is used to group different elements; groupings of elements follow a logic that teachers use in their day-to-day work.
7.Flexibility and Efficiency of Use – operations allow for different users.	The design caters for user ability ranging from novice to expert.
8.Aesthetic and Minimalist Design – no irrelevant information.	Each screen has a short, clear and distinctive title. Use of spacing, colour, white space and typography provide a pleasurable interface experience to users.

9.Help Users Recognise, Diagnose and Recover from Errors – error messages are clear and in plain language.	The help screen is complete, accurate and understandable.
10.Help Documentation – information is easy to find and sets out clear steps related to the task.	Clear instructions are provided on how to set up groups and discussions.
11.De-privatisation	Easy access to groups. Contributors are named and contactable.
12.Interactivity – interactions and tasks support meaningful learning.	Users are able to connect with colleagues in a variety of ways including through special interest groups, and synchronous and asynchronous chats. File sharing is easy. Information is provided regarding dates of posts.
13.Message Design – information is presented with sound information-processing principles.	Use of icons to categorise information.
14.Learning Focus.	Users identify themselves by name, location and contact (email) to enable further questions and contact to be made. Scenarios are professionally located (not social) and are relevant to the professional practice of teachers.
15.Media Integration – the inclusion of media serves sound pedagogical purposes.	Clips support areas for teacher professional development.
16.Resources – resources necessary for	Description of the resources provided, including size,

effective learning are provided.	type, and content of the material. An indicator from other users of the usefulness of the document is provided. Materials contain a sense of the context in which the resource was created and used.
17.IT agnostic.	Usable on multiple devices No specific programs required to access materials.

Table 13: Preliminary Design Heuristics for an On-line Knowledge-Management System

Throughout Phase 3 teacher evaluators continued to be used. Survey data from the first prototype determined that usability criteria had not been satisfactorily addressed, and it was therefore not subject to iterative development . A second prototype was then developed using the Google Plus platform. The second prototype met the ease-of-use heuristics. This allowed further examination of criteria related to perceived usefulness, and in particular an examination of the antecedents to perceived usefulness, as they related to a system for teacher knowledge-management and collaboration.

8.2 Overview:

The researcher was assisted by the organisation's technology department coordinator, who worked with a third party provider to design the first prototype in accordance with phase 2 design principles. User feedback from an initial introductory session was used to refine the first iteration of the prototype. Following a two-week trial and extensive evaluation, the decision was made not to proceed with the prototype. This outcome coincided with a decision by the organisation to implement fully a Google environment across all schools. With the introduction of *Google plus*

making accessible a variety of additional Web-2 tools, the researcher decided to develop the second prototype within that environment. The second prototype was refined through collaboration with a reference group, and built around the subject area of boys' literacy. The second prototype was tested across three schools by twelve teachers, each of whom had some responsibility for delivery of boys' literacy within their school.

8.3 1st Iteration

The prototype specifically addressed design principles related to ease-of-use heuristics. For practical purposes, the prototype was designed as both a student learning-management system and as a teacher knowledge-management system. Whilst this was driven principally by organisational cost constraints (one system not two) it was seen as a positive by the researcher, as users ultimately would not be using and learning two discrete systems. However, this also added an unexpected dimension to the research methodology, as the questionnaire used by participants during data collection was designed to assess general usability not solely from a teacher perspective, but for student use also.

Features of the 1st Prototype (1st Iteration)

The prototype allowed sites to be constructed at system, school and individual level and enabled sharing across schools by storing materials in the cloud. The user was able to engage with the system at the "we" level through cloud navigation, or at the "me" level by placing resources in personal space or in resource folders to which only the user had access. This distinction allowed users to construct and use the prototype at three levels, sub-site (personal), school or system, thereby providing

complete control by the user to meet the personal needs of the individual. The ability to create a school site was supported through a “school wizard” (design principle 9) although the construction and maintenance of the site was restricted to an administrator only.

Construction of each page was facilitated by a cell layout that could be colour-coded, (design principle 1) and colour was used to indicate visibility of the system status for the user. A bespoke menu bar allowed the interface to be customised for the user (design element 3). The prototype had capacity to reflect the information morphology described in design principle 2, that is, information was to be organised into curriculum stages and sub-levels into key learning areas. The prototype, however adopted a modification of this approach by allowing repository items to be saved with an appropriate tag and allowed search of materials based on “tags”. This allowed users to: search using defined tags; to find other users who have tagged similar content; and to recommend material that “people like me” find useful. Recommended materials could also be “pushed” to other users who have “registered” the same interests. A potential problem with this design feature was that the number of tags progressively would become quite extensive, rendering the facility unwieldy and difficult for searchers to find relevant material. This issue would not be likely to emerge until after significant use. This was the experience of users with EDNA, a site that adopted a similar approach.

The prototype incorporated multi-media capability (design principle 14) by allowing images and video to be embedded as a resource either in their own right or as part of a file. Icons were clear and intuitive: + (share), – (minimise), x (delete) and a green pencil icon (edit), (design principles 3, 5 and 7). However, the steps that had

to be taken to save work on the site were not intuitive and the evaluation group experienced loss of their work (when not saved) on a number of occasions.

The design allowed for the incorporation of Twitter (My Tweets), RSS, Resource Lists, Site Navigation and Slideshow. Resources could include blogs, conversation, files, posties, and wikis (design principles 11 and 15). The prototype allowed individual teachers to customise their own sites by allowing them to develop a bespoke menu, store their own materials, select material to push through, provide ratings for materials, post e-notes, and develop new pages with the same functionality of other pages (design principle 3). One of the first comments at demonstration of the prototype was made by a school-based evaluator who noted, “How would staff not be overwhelmed?”

User testing of the 1st Iteration prototype

Seventeen users participated in the first testing phase. These users comprised leaders of pedagogy from the participant schools (3), e-learning advisors and officers (4), and educational leaders from the Catholic Education Office (5) and from school personnel (5). At the introduction session, users participated in a day that enabled them to observe and then use the prototype. Areas covered included personalising learning for students, planning and collaborating with colleagues in the creation of work or projects, sharing and locating resources, building a virtual classroom, and developing and sharing.

During the demonstration day it became apparent that against a number of the design principles, the prototype performed poorly:

- Reliance on flash impacted on the use of the system on i-pads (design principle 16);
- Ability to form groups with teachers from other schools was not clear (design principle 11);
- Uploading of resources was not intuitive and failure to follow the defined steps resulted in work being lost (design principle 5); and
- Not as user friendly as web-2 tools re its ability to collaborate with peers (design principle 11).

Generally however, the response to the prototype was positive with all evaluators either satisfied or impressed with the potential of the system. Users were surveyed at the conclusion of the session.

A summary of the survey results is outlined in the table below:

System Feature	Very Good	Good	OK	Poor	Very Poor
Look and feel of the system	4	10	2	1	0
Ease of creating a learning space	1	6	9	1	0
Logic of the system	1	4	9	3	0
Ease of navigation	1	4	11	1	0
Range of tools	7	6	4	0	0
Ability to customise	3	10	4	0	0

Ability to share with others	3	9	5	0	0
Support for communication and collaboration	1	11	5	0	0
Support for creative thinking skills	1	6	9	1	0
Support for reflective skills	1	8	7	1	0
Support for creative thinking and problem-solving skills	0	6	10	1	0
Multi-modal support for learning	2	10	5	0	0

Table 14: Survey Results Prototype Introduction (n=17)

It was clear from the introduction day that the design principles were validated but that in several key ways the first iteration of the system failed to meet the optimum design requirements. In particular the adding of resources was not seen as intuitive, and the adding of image and video required several steps. During the test phase there was also an issue with the use of the search tool, as it was not fully functional, owing to a problem with the indexing functionality of the system. The individualised nature and aesthetics were seen as excellent, and the knowledge creation opportunity good.

Immediately following the introduction day, the search functionality was restored, and the prototype entered a two-week trial period, during which seventeen users were provided with a set of activities to work through (Appendix ZZ). At the conclusion of the trial, users again completed a survey to capture their feedback, and

the eight school-based participants were interviewed to obtain data regarding their responses.

The survey data is captured below:

System Feature	Very Good	Good	OK	Poor	Very Poor
Look and feel of the system	1	9	5	1	1
Ease of creating a learning space	1	5	8	2	1
Logic of the system	0	4	7	4	2
Ease of navigation	1	6	6	3	1
Range of tools	7	6	4	0	0
Ability to customise	2	6	7	1	1
Ability to share with others	0	4	9	3	1
Support for communication and collaboration	4	4	6	2	1
Support for creative thinking skills	3	3	7	2	2
Support for reflective skills	3	4	8	2	2
Support for creative thinking and problem solving skills	3	3	7	3	2
Multi-modal support for learning	3	5	7	0	2

Table 15: Survey Results Trial Period (n=17)

Users were also asked, on completion of the trial, to compare the system to other tools currently in use:

Feature	Much Better	Better	About the Same	Worse	Much Worse
Creating a virtual learning space	3	7	5	2	0
Ability to personalise learning	4	6	7	0	0
Search capacity	0	8	9	0	0
Sharing digital resources	4	5	8	0	0
Re-using existing digital resources	2	4	10	1	0
Embedding other Web 2.0 tools	3	7	6	1	0
Wiki tool	3	5	7	2	0
Blogging tool	2	5	8	2	0
Discussion forum tool	1	4	11	1	0
Working with multi-media (images, audio, video)	1	7	7	2	0

Table 16: Comparison of Prototype to Other Tools in Use (n=17)

The analysis of results indicates that whilst first impressions were reasonably positive, the number of users who rated the system as poor or very poor increased over the two-week trial period. The product provider was able to stabilise and fix a number of the errors that occurred on the introduction day, such as the search functionality, but a number of the concerns identified on that day, such as the lack of

intuitiveness of the system and the difficulty in navigation and creating content, became clearer during the period of extended use. Of the eight school-based personnel who were interviewed regarding their responses, four had abandoned use of the prototype prior to the finalisation of the trial, due to processes not working correctly and error messages received.

Against the heuristics developed in phase 2, the following strengths and weaknesses were identified through the trial:

	Traditional Usability Criteria (Nielsen, 1994)	Strengths – for a knowledge-management system	Weaknesses – for a knowledge-management system
User Experience			
	1.Visibility of System Status – user is informed about what is going on.		Clumsy and confusing navigation. Too much scrolling.
	2.Match Between the System and the Real World – system uses user’s language and real-world conventions.		Tagging was ineffective as a means of ordering and retrieving materials, as the tags did not follow conventions and could be individually determined.
	3.User Control and Freedom – user can select and sequence tasks.	Ability to configure the look and feel.	Too many steps required – non-intuitive.
	4.Consistency and Standards – consistency in words, actions and objects.	The “we”, “see”, “me” metaphor was useful in helping users distinguish the interfaces designed for personal, group and system use.	Cluttered interface. Unimpressed with the layout.

	5.Error Prevention – careful design eliminates errors.		Functions did not work correctly and error messages were received frequently.
	6. Recognition Rather than Recall – actions, objects and options are visible. Instructions visible and clear.		Users noted that extensive professional development and support would be required prior to use.
	7.Flexibility and Efficiency of Use – operations allow for different users.		Required significant professional development in order to feel proficient.
	8.Aesthetic and Minimalist Design – no irrelevant information.		Cluttered interface.
	9.Help Users Recognise, Diagnose and Recover from Errors – error messages clear and in plain language.		
	10.Help Documentation – information is easy to find and sets out clear steps related to the	Help documents covered most issues.	Help resources were documents only and did not include video/multi-media.

	task.		
Additional Heuristics			
	11.De-privatisation.		
	12. Interactivity – interactions and tasks support meaningful learning.		Search and share features did not work.
	13.Message Design – information is presented with sound information-processing principles.		
	14.Learning Focus.		Learning sequence functions did not work properly.
	15.Media Integration – inclusion of media serves sound pedagogical purpose.	Embedding of video was straightforward.	Not as “friendly” as other Web-2 applications.
	16.Resources – resources necessary for		

	effective learning are provided.		
	17.IT agnostic.		Not suited to mobile devices.
New Additional Criteria	18.Flexible Learning Spaces.	The ability to create “my space” allowed teachers to create their own reflective learning journal.	

Table 17: Heuristic Evaluation of the First Prototype

In analysing the themes from the first prototype, it was evident that a number of the teachers used and appreciated the functionality of “my spaces” that allowed individuals to construct their own professional page. Whilst generally this was used as a repository for materials useful to the teacher, there was also some evidence that in a basic fashion it was being used as a running record and reflective tool allowing the teacher to note for a particular class what had been planned, how well the activity had gone, and what would occur in the follow-up activity. This was not a strong theme, but in the context of a site designed to support teacher learning, it was included as a possible additional criterion to be tested by the inclusion of a relevant feature in the 2nd prototype, as discussed in section 8.4 below.

At the conclusion of the trial, three questions were asked of the users in relation to their intentions to use the system. The questions and the responses are as follows:

1. How do you think your teaching colleagues would respond?

Most would not use it	18%
Some would use it, but many would not	24%
Roughly half would use it effectively	24%
Many would use it effectively	29%
Most would use it effectively	6%

2. Would your school adopt the system and discontinue what you currently use?

We wouldn't adopt it	12%
We wouldn't adopt it and would continue our current system	29%
We would adopt it but would continue our current system	35%
We would adopt it and would discontinue our current system	24%

3. Would you recommend that the system be further developed for use across the system?

NO	36%
YES	35%
Undecided	29%

The survey results and interviews indicated that the ease of use of the prototype was low, with more weaknesses than strengths when matched against the heuristics developed in phase 2. This outcome clearly impacted on the attitudes

towards the system and the subsequent intentions whether or not to use. Whilst there were positive responses across a range of items, and therefore potential for further development, the high cost of continuing to work on the prototype and the risk that teachers would prefer to continue to use Web-2 tools, led to an organisational decision to discontinue work on the system. The experiences of both phase 1 and phase 2 indicated the difficulty in meeting effectively the *ease of use* heuristics for a knowledge-management system.

At the time the decision was made, Google launched its Google Plus environment, and the decision was made to adopt the Google platform throughout the organisation. Organisationally this meant that extensive training for all staff accompanied the roll-out, and that for the first time, all staff resided on the same global e-mail system. An evaluation by the researcher of the Google Plus features, especially the social networking tools of posts, circles, rich snippets, hash tags and email notifications, led to a decision to use the Google Plus platform for the 2nd prototype.

A new reference group was established, as described in chapter 5, to inform the design of the prototype. It was anticipated that an advantage critical to the use of the Google Plus environment was that basic functionality, such as search capability and help functions that had proven difficult in the first prototype, were not only well-developed, but assistance was abundant on the web should users encounter difficulties. The Google Plus environment also had potential owing to its ease of control, to move from a limited, rigid prototype infrastructure to one that allowed users to manage the flow and appearance of content in ways that met their needs. This allowed the development of the second prototype to focus not only on the *ease*

of use heuristics, but also on the *perceived usefulness* of the prototype for its purpose of supporting knowledge-sharing by teachers.

The factors contributing to *perceived usefulness* were derived from the work of Venkatesh and Davis (2000), who proposed that there were additional variables that could be added as antecedents to *perceived usefulness* and that act therefore as predictors to intention to use. These form what they refer to as the TAM 2 model, and comprise subjective norm, image, job relevance, output quality and result demonstrability. These factors are described in the table below:

Determinants	Definitions
Subjective Norm	The degree to which an individual perceives that people important to him/her think that he/she should or should not use the system.
Image	The degree to which an individual perceives that use will enhance status.
Job-relevance	The degree to which the system is applicable to the job.
Output Quality	The degree to which the individual believes that the system performs his/her tasks well.
Result Demonstrability	The degree to which the individual believes that the results of using the system are tangible, observable and communicable.

Table 18: Determinants of Perceived Usefulness: Adapted from Venkatesh & Bala 2008, p.277

The reference group worked with the researcher in order to identify three schools in which the Google roll out was well progressed, and where there was a focus area of common interest that would have relevance for teachers. The focus area for the prototype was agreed to be Stage 4 Boys' Literacy, an area that was targeted by each of the schools for improvement and that consequently related directly to the goals of teachers in the classroom. The principals of the schools were approached; all agreed to participate and also agreed to the active involvement of their e-learning coordinators in the design of the prototype. On this basis, it was assumed that criteria regarding subjective norm, image and job-relevance were, at least in part, addressed prior to the trial of the prototype.

8.4 2nd Design Iteration:

The reference group was used extensively throughout the development of the second prototype in order to ensure that the design was focused on meeting the additional heuristics required for a knowledge-management system. It was decided that rather than using the original (Google) names for the resource cells (e.g. resource, blog, wiki), names would be appropriated from the four-fold taxonomy developed by Little (1990) for examining collaboration. These were **Storytelling**, used for case-study analysis; **Aid and Assistance**, used for requests for help in blogs; **Sharing**, used for methods and materials accessible through the resource library; and **Joint Work**, used for wikis. **I Wonder** was added for use as a reflective journaling tool, taking advantage of the "My space" design in the first prototype. Teachers were encouraged to identify one student each term who intrigued them and to reflect weekly on how they had improved that student's learning. Configured as a private

reflective space it was anticipated that teachers would move significant learning from this space to the networked space, as appropriate.

On the advice of the reference group an additional menu tree was established that allowed users to search and contribute under: assessment for learning; cross-curricula programs; differentiated instruction; file cabinet (the repository); and scaffolding student learning. This additional menu also ensured that use of tags followed an agreed structure that would enable easy identification and retrieval, thus alleviating the problems that had been identified in phase 1 with *MyClasses* and phase 2 with EDNA, in which unrestricted tagging created confusion and retrieval difficulties. In the final iteration modifications were made following reference group feedback also to include each Key Learning Area (KLA) as discrete searchable areas, as this would encourage teachers to use the site. Also as recommended by the reference group, the final iteration provided an explanation of each area so that users easily could understand its purpose. The following explanations were added as banners to each page:

Home – A computer was installed in a hole in the wall in a slum in India. Within days, children aged 6-12 with minimal education were able to browse the web and use the computer. This is your "hole in the wall". Have fun orientating yourself, contributing and tapping into the wisdom of others!

As you work through this site ask:

- Is there another way of looking at this?
- Why do I think that ...?
- Why is it ...?
- Can you say more on that?
- Is there any evidence that ...?

Specifically in relation to Boys' Literacy:

- What does your analysis of Naplan tell you?
- Where are the areas for growth?
- What have been your strong strategies and where are the areas for growth?
- What can we learn from each other?

Aid and Assistance – Anything you need to know? Tap into the wisdom of the group and ask a question. No wrong answers – just a chance to share what you have tried, what you have heard about, or who you know who might be able to help. Just click "add comment" and you'll be started. Search for themes or keywords to tap into the wisdom of others.

Joint Work – Here's where you and others collaboratively develop resources. Don't forget to save your work in the boys' literacy folder "in the cloud" – otherwise others won't be able to access it. You can also use Google groups to make comments on works in progress.

Sharing – Found something useful to share? Here's where you can place it so that others can take a look. Try and include a description of what it is and how you found it useful – that will cut down the work for others who might be time-poor and trying to make a quick assessment of what will be helpful. Here's where you can post those digital learning walks.

Story-Telling – They say that context is everything. Don't forget to fill in just enough detail so that others can imagine your class or situation. This will allow others to make an informed judgment as to how what you have done can be applied to or modified in their own situation. Click on the "open story-telling" icon below the table and don't forget to save when you finish!

I wonder – Much has been written about the inquiring teacher – discovering the relationship between what you do and what happens to the student. You may have one student or a group of students who "puzzle" you. Ask yourself "what is happening for this/these student/s in my classroom?"; develop a working hypothesis; research and craft some knowledge, and give it a go. You can share your journey here!

8.4.1 Trial of the 2nd Prototype:

The trial of the 2nd prototype took place over a period of twenty two weeks spanning the final term of the 2012 school year and the first term of the 2013 school year. In introducing the prototype to the school principals it was made clear that:

- 1) No additional time would be allocated to those schools participating in the trial as it was important that use of the knowledge-management system by teachers was as close as possible to “normal” professional work conditions;
- 2) The knowledge-management system would not be introduced to staff by the researcher, but would need to be introduced to staff by key educational leaders in the school as part of their leadership role. This could be the curriculum coordinator or other individuals with specific responsibility for learning and teaching within the school; and
- 3) It was anticipated that the e-learning coordinator would from time to time be requested as part of the role to moderate discussions, as the scaffolding of discussions was one of the principles that was to be tested.

As outlined in chapter 5, e-learning coordinators met the identified teachers at each of their schools to discuss involvement in the trial. From those discussions a

request was made for the teachers at each school to be linked via a video-conference in order that they could introduce each other, discuss their area of interest, receive an overview of the prototype and ask questions. The researcher agreed to this request, as once the prototype was released, teachers would be able to mimic this requirement through the use of circles in the Google Plus environment.

During the teleconference, the question was asked regarding an allocation of time to teachers to facilitate their use of the site. The e-learning coordinators advised teachers that time could be made available as part of the additional release time already allocated to the improvement of boys' literacy.

During the trial period the researcher did not intervene or prompt use as the purpose of the trial was to have the prototype used in accordance with the normal day-to-day practice of teachers. E-learning coordinators at each of the schools were given author rites to the site in order to ensure responsiveness and flexibility to meet emerging needs of teachers. After the first term of use (10 weeks), the e-learning coordinators, at the request of the researcher, approached the 12 users to enquire as to whether there were any issues with the site design that impacted on its use and which would require modification. Eleven users indicated that the design of the site was clear and easy to use, options easily accessible and that no changes were required. One user indicated that the language "story-telling" was not initially clear. However, given that the meaning had been subsequently clarified and that no other users raised this issue, no change was made to the site.

(LC) – it's very user friendly and it's structured really easily. Visually and technically I'm very familiar with Google sites".

(AL) – It's good. The delineation of the KLAs works well for me. If I'm time pressed I just want to see what's particular to my subject, if I'm honest.

(ML) – It is nice and simple, it is fine. I like the categories – the site is lovely.

(PS) – I use a lot of websites. The interface is good.

However, at the end of the trial period, there was very little use of the site amongst users. These results were surprising to the reference group and to the e-learning coordinators at the school. Whilst the results are discussed more fully below, some general observations are:

- 1) There was no use of the “aid and assistance” page, designed to support discussions between colleagues. Accordingly there was no basis upon which the e-learning coordinators were required to facilitate or moderate topics.
- 2) The repository function “file cabinet” was not used.
- 3) The “I wonder” section, designed for personal learning journals was not used.
- 4) “Story telling” was used by several of the users.
- 5) A small number of contributions was made via comments on the home page.

Having earlier established the site's usability, the researcher focused the data gathering on an examination of the *perceived usefulness* of the site. Data were gathered through one-on-one interviews with each of the users. Interviews were of

approximately one hour's duration and were semi-structured, using pre-determined interview questions (Appendix Z) and appropriate follow-up questions, as applicable. At the conclusion of the formal interview, users had opportunity to discuss more generally any other issue that they believed pertinent to the failure of teachers to use the site.

The results are reported by theme with reference to individual differences between schools and the social context of each school environment.

8.5 Results.

The results of the trial of the 2nd prototype are discussed below in themes based on *perceived usefulness* heuristics.

1. Job relevance – The degree to which the system is applicable to the job.

The schools that participated in the trial were recommended on the basis that they were all focused on boys' literacy. The principals of the schools indicated that boys' literacy was a school goal and that it was an area that individual teachers were focused on. The teachers who participated in the trial were seen to have teaching responsibilities for boys' literacy in their school and had indicated at the initial meeting a great enthusiasm for learning from each other around the common goal. In particular, teachers at school (L) saw great advantage in linking with the other boys' school (C) and with school (S) that had high academic achievement. School (C) was particularly interested in connecting with school (S) to learn about high result strategies, and school (S) with the other two schools to understand more about working with students who were struggling. Notwithstanding these initial views, in the final analysis the commonality of the goal was in reality quite low.

The goal of school (C) regarding boys' literacy could not be clearly articulated by the teachers who participated in the trial. During 2012 there had been a number of short-term strategies and during 2013 an attempt was made to create greater focus by developing a sustainable literacy plan. Unsurprisingly, individual teacher goals regarding boys' literacy were ill-defined and consisted primarily of completing a professional development program, *Literacy: The Next Step*, and the integration of literacy strategies into programs. Whilst there was some reference to NAPLAN tests, there was no clearly articulated goal that the teachers could refer to regarding the level and type of improvement that was being sought either at a school level or for individual teachers.

The goal of school (L) regarding boys' literacy was focused primarily on English as a Second Language, therefore the focus for individual teachers was on developing class strategies that integrated discussion and conversational style in order to tap into boys' expressive capabilities. The individual teacher-focus was on strategies such as assessment, classroom activity, pre-reading, and on texts that would engage boys.

School (S) was described by the e-learning coordinator, prior to the trial, as a school in which boys' literacy goals were incorporated into the annual goals of every teacher. An analysis of teacher-responses indicated, however that the school was not specifically focused on boys' literacy, but on improving overall NAPLAN results. NAPLAN data at the school indicated that there were not specific gender issues regarding literacy and therefore there were general literacy goals only. Literacy was seen as part of a whole-school framework. As a school with high academic achievement, the focus for teachers was on moving "middle" students to higher

attainment levels and on extension activities for top students. This focus was not only on literacy: teacher (PS) spoke about his personal goal being to improve outcomes in high-order numeracy.

It was therefore clear that at the level of individual teachers, there was little commonality in the goals that each school had set regarding boys' literacy, and therefore little commonality in the individual goals of the teachers involved in the trial. With this scenario, it was therefore not surprising that teachers did not utilise the site as often as was anticipated that they would.

Teachers did support the principle that on-line collaboration and learning could support them in their roles. However, in most instances, the type of activity they were referring to was the accessing of professional materials. For example, teacher (ML) spoke about being the only Italian teacher at the school, and the importance of being able to contact colleagues for programs and lesson plans. Similarly teacher (JC) referred to being the first teacher of multi-media, and accessing resources from another school. Teacher (JC) referred to use of TWITTER to enquire about game-based learning. All teachers referred to on-line access to professional bodies for resources. For example, the National TAS Professional Association has over 3000 TAS teachers nationally, working across sectors and across state jurisdictions, and teachers use the site to access assessment tasks, resources, materials and equipment.

Despite the failure to use the prototype site, teachers still expressed a belief that on-line collaboration and learning would make their job easier and would help meet specific individual goals. Teacher (PS) stated, "Yes, collaboration assists in the role. It helps create new ideas, new directions. On-line collaboration is essential to

teachers in the future – it's what students will be doing in the classroom". Teacher (RS) believed that on-line tools allowed access at a time that suits individuals and at time of need. She believed teachers would use on-line collaboration to explore roadblocks, difficult students, lessons that weren't working, and boring lessons. Teacher (DS) stated that she would use on-line collaboration to gain access to the expert knowledge of others.

However, within each interview, there was a high degree of internal inconsistency in the responses to how an on-line system could be used. Whilst universally there was a belief that use could make the role easier, particularly in gaining access to classroom resources, responses to the other heuristics indicated that teachers would not use the system, or would use it only minimally, particularly in relation to reflection on professional practice.

2. **Subjective Norm** – *The degree to which an individual perceives that people important to him/her think that he/she should or should not use the system.*

To examine this question, the researcher asked a series of questions related to school practice around the use of Google, and around on-line collaboration, professional development and learning.

At school (C) teachers actively used Google to develop sites within their faculty, in which resources are shared between faculty colleagues. Teachers were encouraged to add to, change and develop teaching resources. At school (L) all staff had attended Google Guide and Cloud-share training, and a number of Google Groups had been set up within the school. All teachers at school (S) were familiar with the Google platform. Introduced in 2012, it had grown in momentum and use.

Technical issues were reported with accounts routinely disabled. “When this occurs, staff can’t access their resources, so there is a reluctance to use Google as the sole repository” (RS). For this reason, Moodle was used as an in-school platform that was still preferred over Google. In each of the schools, the use of Google was being promoted positively for use by departments within the school. There was no evidence of general teaching staff using the Google platform for networking beyond their school. The researcher concluded that use of the Google platform within a school would enhance the professional reputation and standing of the teachers as being contemporary in their approach to resource-sharing with colleagues, but that there was neither expectation nor status in using the platform to connect beyond school boundaries.

The primary source of dispersion of new ideas and resources across schools was through the Key Learning Area Coordinators (KLACs). These coordinators attended network meetings twice a year with colleagues from other schools. Coordinators were present at these meetings. There was generally prior-reading before the meeting, Q and As that emerge from the discussion, and resources posted on an open site for all teachers to access. Only the KLACs had editing rights. The KLACs brought back practices and ideas that were shared through faculty meetings. These coordinators acted to filter what information (if any) was transferred to the teaching staff. “Whether something new gets taken on board has a lot to do with the executive” (ML). Teachers at school (L) did not work outside of their KLA. Whole staff professional development and staff days generally allowed staff to remain in and discuss issues within their own KLA and initiatives would be continued through KLA meetings only. The researcher concluded that there was little encouragement

for teachers to work beyond the boundaries of their own faculty, much less at whole school level, and that for the most part the teachers were passive recipients of new knowledge. Any status associated with cross-school networking and the sharing of new or different practice was confined to the KLA role.

Professional development was primarily experienced as face-to-face and occurred predominantly at the school, either formally through staff development days, or informally in face-to-face meetings and discussions. Coordinators occasionally organised voluntary sessions within their own school and outside of school hours, where staff would discuss with school colleagues approaches used in their classroom around particular topics. There was opportunity for teachers to present and attend at voluntary “teach meets”, at which teachers from across several schools present to colleagues around action learning projects. These encouraged teachers to reflect on what worked and what did not work around particular strategies they had used, but only a small number of teachers at the trial schools had attended or contributed.

The main opportunity that teachers had to meet and collaborate with colleagues at other schools was through system-delivered professional development or as part of specific projects. An example of the latter was a visit by the maths faculty of school (C) to two adjacent high schools to observe classroom preparation. This was not followed-up with any formal (or informal) collaboration between the schools. Use of on-line learning had been limited to participation in tutorials on the use of Web-2 and i-Pad, and short on-line sessions on the use of TWITTER, or sites that formed part of professional development programs.

Cross-school networking was not something that individual teachers were rewarded for. Formal structures such as network meetings encouraged a passive approach to the adoption of new ideas and practices. Teachers were reliant on the KLA coordinator to filter the materials, and to determine which, if any, were shared at staff or faculty meetings. Whilst collaboration within the school occurred, structures and processes for sharing focused primarily on a specific department as opposed to whole-of-staff.

3. **Image** – *The degree to which an individual perceives that use will enhance status.*

Whilst teachers were willing to use on-line tools to gain access to professional materials, there was an expressed reluctance to use such a system to reflect on professional practice and for professional learning. This reluctance, whilst also present in face-to-face interactions, was more prevalent in the on-line environment with which teachers perceived there was a real risk to their reputation.

Teacher (LC) stated that reflection on practice in the classroom would depend on how comfortable she felt in expressing what occurred, especially if it was negative or something she didn't feel confident about. She stated "I would only share something positive on the website. (With regard to) negatives I would feel judged or worry that someone was reading it out of context. The tone is not there so it's hard to express". Teacher (RC) similarly expressed, "If you try something innovative I'd worry that my class was going to be loud and noisy and I'll disrupt others. I'd be concerned about what others would think or that others will think that the kids aren't learning".

Teacher (JC) reflected that the same level of reflection is not visible in on-line forums as is experienced in face-to-face forums. When asked why, she responded: “teachers are very aware of their digital footprint and if you put that out there, it’s almost as if you’re putting yourself down. It’s hard to gauge intent in the electronic form”. “Face-to-face if somebody wanted to ask you a question to get you to expand on any problems that you have, then you read body language – anything electronic is more like the written word and it raised the level of importance in what you say.”

Teacher (DC) went so far as to state that he would need an initial face-to-face meeting where he got to know someone, before he would share more deeply. Otherwise he would only look for resources for the class. Teacher (PS) stated he would want a profile of the person so you could say, “oh, they are interesting, I’d like to ask them something”.

The approach of teachers to what constitutes learning was very insightful. Whilst theoretically all could acknowledge that learning could be gained as much from experiences and activities that didn’t work well, as from those that did, there was a deep reluctance on the part of the teachers to de-privatise those experiences that didn’t work. There was an expressed level of concern among the teachers regarding the permanency of the digital footprint, particularly in situations when the sharing of unsuccessful practice is concerned. Teacher (MS) stated “It can be quite daunting for teachers to criticise themselves because we’re so used to be criticised anyway, but you don’t really want to be doing it to yourself when its permanent (in an on-line environment)”. Teacher (JC) believed it was more difficult in the electronic medium to make the connection between constructive criticisms or between constructive and criticism. She stated, “I think that teachers need to be more

confident ... we don't trust ourselves and we always think that other people are going to be looking down on us as much as we look down on ourselves. It's the self-reflective ones that are really hard on themselves. The school system can't change it, it's something that has to change in society because society looks down on teachers as well".

Teacher (AL) stated, "there's a lot of shame around things that don't work. There's a self-conscious moment where someone will say, "guess what I did that completely failed". At the e-learning forum I admitted something didn't work. I only said it because somebody before me on that day admitted that something didn't work so I thought OK, let's all put it out there ... it was nice actually, it made the day more honest. Sometimes those days are a little bit showy and we all sort of try to cover up whatever went wrong and bring the "A" kids' work instead of the "C" kids' work." In referring to the permanency of the on-line environment, teacher (AL) stated that she was conscious that the judgement around her work continues past the time when she is conscious that it exists: "There's a permanency to the on-line environment that freaks me out a little bit".

Teacher (PS) – "teachers are uncomfortable putting things up – worried that they will be judged and people won't think its up to scratch".

Teacher (RS) – "it would require honesty to say "I'm struggling"".

It was also interesting that a number of teachers viewed that a positive contribution could also be a negative with respect to status among peers. Teacher (ML) summed this feeling up with the following statement "I would feel personally that people would think that I was boasting". Teacher (DS) stated "with reflective

practice, unless you know the people it is quite threatening to put yourself out there. There are perceptions of arrogance. With on-line you can't pick up the tone".

4. Output Quality – *The degree to which the individual believes that the system performs his/her tasks well.*

In relation to the prototype, there was no direct commentary on this aspect of the usefulness criteria. However, by implication a number of teachers expressed doubt as to whether something from another school could be useful to them in their work.

Teacher (JC) – There's a fairly strong impression that what works at another school won't necessarily work well here, that it would have to be modified anyway. There's a fair bit of communication between KLAS at the school, but with other schools, not so much."

Teacher (AL) stated "Collaboration would be useful, but "English is incredibly localised".

5. Results Demonstrability – *The degree to which the individual believes that the results of using the system are tangible, observable and communicable.*

This aspect was not referred-to by any of the teachers.

When asked to suggest why the prototype was not used, several issues were raised, the most common being a lack of time and competing system priorities. These are detailed below.

6. Competing System Priorities

The release of the prototype coincided with significant change processes across the system that impacted on all teachers. These were changes to the legislative requirements for the recording of student attendance, which necessitated the introduction of a new electronic system for the marking of absences and the tracking of student data; and the introduction of the National Curriculum that required all staff to participate during term 1 of 2013 in staff professional development and to familiarise themselves with the new curriculum. These changes were experienced by the teachers as both demanding and time-consuming and were stated to have had an impact on their ability and availability to take on something else that was new.

Teacher (NL) – “Other agendas such as National Curriculum have come in over the top and this.”

Teacher (PS) – “ I didn’t use the site – I’m drawn to it but it got overlooked due to the busyness of the school – we had a new system for attendance that changed timetabling, rolls, and reporting marks. It was a steep learning curve. (We had) new syllabuses and a new strategic plan. At the time I thought, “I have a lot of things to put up there (on the boys’ literacy site), such as persuasive language and techniques, but I couldn’t get to it”.

7. Lack of Time

Every teacher interviewed referred to a lack of time as being a primary reason for not using the site.

Teacher (DS) – last year was a very busy year – I didn’t have time to use it but it looked good.

Teacher (LC) – “I don’t have time for anything other than my set lessons. You end up with individual personalities, school requirements, with the system, and then the requirements of everyday teaching, the requirements of everyday administration and just none of it was conducive to making it work”.

Several of the teachers indicated that to create an environment in which the on-line system would be used, there would need to be structures and processes built into the school timetable. Suggestions ranged from mandating the use of the system, through to providing an hour each week when teachers would be required to contribute. One teacher (JC) stated that teachers could be “rewarded” for use by recognising with professional development hours under the NSW Institute of Teachers.

Conclusion

The Technology Acceptance Model (TAM) provided a useful framework for the design and evaluation of the prototypes developed for a knowledge-management system for teachers. The first prototype demonstrated clearly that unless the *ease of use* criteria are met, teachers will not persevere in the use of the system and will instead continue to use the tools that they are already familiar with. Users saw the second prototype as meeting *ease of use* criteria. All users commented favourably on the design, and the decision by the researcher to use a platform that had been adopted by the whole system and that overcame issues identified in the first trial about the need for high levels of professional support and training on the system. The use of the Google platform also meant that there was flexibility in the system design, and the incorporation of all of the social collaboration tools that teachers had recognised as being important to them. The only *ease of use* criteria that remained ambiguous

following the trial was design principle 14, learning focus, which stipulated that “Users identify themselves by name, location and contact (email) to enable further questions and contact to be made”. This is discussed further below, but there remains an expressed tension between the desire for users to know who is contributing materials and how they can be contacted, and an expressed reluctance to be identifiable in case there is a professional judgement made about the contributor.

Even though the *ease of use* criteria was met and the teachers, after the second trial, indicated that use of the system would help them in their roles, there was no widespread or sustained use of the prototype.

This reluctance to use the prototype is in part explained by an analysis of *perceived usefulness* against the antecedents outlined in the TAM2 model (Venkatesh & Davis, 2000). The results are summarised below with specific reference to the trial results:

Subjective Norm	The degree to which an individual perceives that people important to him/her think that he/she should or should not use the system.	Whilst the principal of each school supported teacher participation in the trial, priority and importance was given to other system initiatives such as National Curriculum introduction. The school goal for boys’ literacy was not compelling and had not been internalised by the teachers as having a specific importance to their work.
Image	The degree to which an individual	Use of the Google platform was

	perceives that use will enhance status.	professionally well regarded within each school. However there was little encouragement to use beyond school boundaries. Collaboration was viewed primarily as an activity that occurred with colleagues from the same department within the school.
Job-relevance	The degree to which the system is applicable to the job.	Teachers expressed a view that on-line collaboration assisted their job. However, concerns regarding time and judgement of colleagues prevented use.
Output Quality	The degree to which the individual believes that the system performs his/her tasks well.	Teachers were focused only on resources for their class and had other tools to access these. Local context was seen as a barrier to sharing materials. Conversely, the story section of the prototype was used and well-received.
Result Demonstrability	The degree to which the individual believes that the results of using the system are tangible, observable and communicable.	

Table 19: Summary of Results against Antecedents to Perceived Usefulness

Venkatesh and Davis (2000) demonstrated that the TAM 2 model performed well in both voluntary and mandatory environments, and that the subjective norm had no effect in voluntary settings. However, whilst the results of the trial indicate that TAM 2 would have predicted use of the prototype by teachers, this did not

occur. In part this can be explained by a deeper analysis of the antecedents to the perceived usefulness of the prototype, but this may not fully explain the results. Other social influences were identified from the data. These are described briefly below and will be further analysed in the concluding chapter and considered in the determination of the design principles.

1. Innovation and Intervention

The introduction of the prototype to trial was an innovation when considered against the prevailing social context of the school communities that were involved in this study. It occurred at a time when there was a technology push around three other systems – the Google platform roll-out; the roll-out of the National Curriculum training modules; and the roll-out of new e-reporting for student attendance and outcomes. Whilst the first of these was an enabler for adoption of the prototype, the other two were mandated activities that had a whole-of-system priority, and a pre-determined implementation with respect to timelines and outcomes. Teachers were required to comply with use of those systems. Compliance, in this sense, is defined as a situation in which an individual performs a behaviour in order to attain certain rewards or avoid punishment (Miniard & Cohen, 1979). The last two initiatives were seen as competing with the prototype for the time and attention of the teachers.

Analysis of the final data also indicated that the prototype was a more radical innovation than had been anticipated by the researcher given the facilitating conditions that had been described, that is:

- the input from the school principals and the e-learning coordinators regarding the commonality of purpose;

- the stated readiness of staff for on-line collaborative activities; and
- the expressed desire (during phases 1 and 2) for a system that would deliver the outcomes of the prototype .

This outcome is further analysed in the concluding chapter with regard to the Innovation Diffusion Model.

2. Motivation to Use

TAM 2 did not predict any difference between voluntary and mandated activities. However, this research suggests that once *ease of use* criteria were met, the motivation to use the system became critical in the determination as to whether *perceived usefulness* translated into actual use. Phase 1 determined clearly that a number of the motivating factors for knowledge sharing in virtual communities of practice had been met. In particular, participants in the first phases of the research identified that sharing was seen as a means of establishing ties with others, (Scarbrough, 2003). Sharing was seen as a way of assisting individuals to meet the challenges of their role (Scarbrough, 2003); and sharing with colleagues within the same system of schools was viewed as a way of building stronger links around areas of common interest (Ardichvili et al., 2003; Chiu et al., 2006; McLure-Wasko & Faraj, 2005; Scarbrough, 2003).

However, the antecedents for *perceived usefulness* under TAM 2 did not fully align with other dimensions identified for motivation for knowledge-sharing in virtual communities of practice, and this may in part explain the lack of use of the prototype. Only the first characteristic, status and career advancement, had an

alignment to subjective norm in TAM 2, whilst the remaining dimensions are not considered in the model.

Dimension	Source
Status and Career advancement, enhancement of professional reputation. Emotional benefits (boosting self-esteem). Being able to contribute, being useful. Intellectual benefits (developing expertise, expanding one's perspective, finding new challenges).	Ardichvili et al., 2003, 2008; McLure-Wasko & Faraj, 2005; Scarbrough, 2003. McLure & Faraj, 2000; Van Winkelen & Ramsell, 2003. Chieu et al., 2006; Van Winkelen & Ramsell, 2003; Garfield, 2006; Vestal 2006.

Table 20: Motivation for Knowledge-Sharing in Virtual Communities of Practice (VCoP). Modified from Ardichvili, (2008, 54).

The importance of the other dimensions are considered in the concluding chapter and analysed in terms of impact on the design principles.

3. Professional Knowledge vs Professional Practice

The results of the trial indicate that the predominant practice among teachers was to use Web-2 tools to source material for classroom use. This included repository-type materials such as lesson plans and programs, and student-focused resources that could be used within the class.

There was little evidence of any use of Web 2 by teachers to promote personal learning around professional practice, even though this was the domain that teachers in phase 1 and phase 2 expressed a desire to develop. Learning around

professional practice requires reflection, and not only was this not evident in the on-line environment, but also it was not actively supported by face-to-face opportunity in a planned and systematic way within the schools. Teachers remained anxious about peer judgement, and whilst they had few opportunities for this type of learning with colleagues, when there was opportunity they expressed the importance of being able to receive in-time feedback from the body language and tone of voice of colleagues.

Teacher (AL) summed it up as follows: “I would need to see the honesty in person. In a meeting I feel as if I can manage the impressions of others as it’s a simultaneous feedback environment and you don’t have that with an on-line environment. My uni has the same issue – “If there’s something that’s gone all right they’re happy to go on to the forum and tell all the bright ideas and intimidate everyone else, but when things don’t go well they email the professors privately.”

Dispersion of new ideas and practices was reliant on the Key Learning Area Coordinators (KLACs), who were the only teaching group that had the advantage of regular involvement and participation in cross-school network meetings. The KLACs acted as filters to determine which practices within the school were showcased at network meetings, and which practices from other schools would be shared back in their own environment.

The social context of teacher learning is further discussed in the concluding chapter and the findings referenced against Connectivity Theory and Activity Theory as a way to understand both the current practice and the cultural constraints to teacher learning in the professional practice domain.

4. Collaboration

Teachers spoke positively about collaboration and the potential for positive impact on the job. However, collaboration is primarily viewed as a face-to-face activity that occurs either formally through structured in-service or informally, through existing social networks. On-line collaboration is seen as something that “should” occur, but is viewed with a high level of suspicion. The on-line environment is viewed as having an as-yet unrealised potential. Teacher (RS) stated that it takes 2/3 longer to collaborate, therefore you do a cost/benefit analysis and only collaborate on high-stakes issues. These comments suggest that there is little internalisation of a belief about the true value of broad-based collaborative activity into teachers’ own belief structures. The stated intention to use an on-line system for teacher collaboration is an espoused belief, and the difference between the actual and the espoused is further explored in the concluding chapter, with specific reference to the implication for design principles.

5. Time

Time was mentioned by every teacher-participant. Teacher (DS), who used the prototype stated, “It took a fair bit of time but I sort of felt it was valuable”. Other teachers, who continued to espouse the value of the prototype, had suggestions as to how the issue of time could be overcome. Teacher (ML) for example stated “You need to embed one hour after school or one period during the week, or during the holiday when you could do one hour, two or three times in the week and it’s considered part of your reading and learning and can be part of your resume”. She elaborated, “It needs to be a priority and part of every-day practice”. Teacher (RS) reflected on the changing pace of the teaching profession, “There is no more time.

Teaching is much busier now than 20 years ago with syllabus changes, risk, WHS. Free periods are taken up. Already I do all my marking at home. You would need a period per week for on-line collaboration.” The concern regarding lack of time is considered a strong disincentive by teachers in the use of on-line collaboration and learning. However, care would need to be taken around the proposed solution, which is to mandate the participation in on-line collaborative activities. The strength of concern around peer professional judgement and the lack of evidence of existing learning around teacher professional practice, would suggest that the provision of time alone, would be unlikely to change substantially the pattern of use.

It is clear from the trial that even though the research methodology involved the users as designers and co-creators of the on-line knowledge-management system, there remained barriers to the individual’s participation and use of the prototype. A number of organisational factors contributed to the lack of use by teachers, with users naming time and the simultaneous roll-out of other major initiatives as inhibitors. However, the reluctance of users to contribute to an open exchange of ideas and information, has significant implications for the design principles, and is discussed in the concluding chapter.

9 REFLECTION TO PRODUCE DESIGN PRINCIPLES

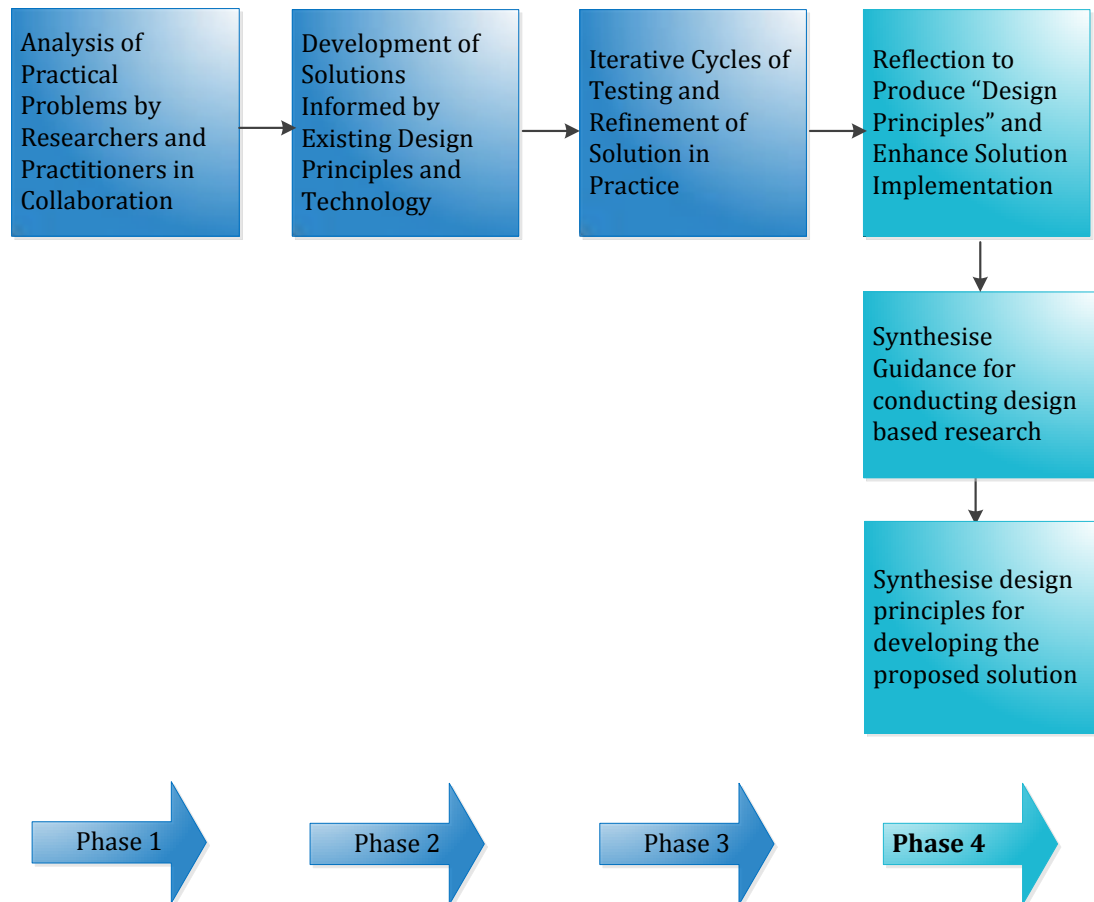


Figure 14: Design Research Phases adopted from Ma & Harmon, 2009: Phase 4 Steps Described

9.1 Introduction

The focus on the preceding phases has been on the use of literature, theory and practice to design an intervention – in this instance a prototype knowledge management system to assist teachers in improving their pedagogical practice. Phases 1-3 were a collaborative partnership between researcher and practitioners and involved multiple iterations of design that were tested by teacher evaluators for relevance and application to their work. This Chapter focuses on the final phase of the research, Phase 4. The above diagram outlines the focus of Phase 4, the synthesis of findings in order to develop and document a coherent set of design principles. Implications for further studies are identified and indicators provided to inform future understanding of *usefulness* criteria as they apply to teachers

The chapter provides a brief summary of the design research approach, a discussion on how the findings relate to literature, and outcomes described as a set of design principles that can be applied to the development of a system to support teacher knowledge-sharing. Implications are presented for teacher on-line collaboration, system policy and implementation methods. Recommendations are made for further research into voluntary on-line collaborative learning and knowledge-sharing among teachers.

9.2 Summary

A multiple-iteration design-based research study was conducted to develop a prototype for on-line teacher collaboration and knowledge-sharing. The study was

conducted across three phases and involved a total of 160 teachers. In this, the fourth phase, conclusions are drawn and design principles developed. The purpose of the study was to collaborate with practitioners to design a knowledge-management system that would be purposeful in meeting their needs. To inform the design of the system, the following questions were addressed:

1. What are currently the key practices for on-line knowledge-management and retrieval, and what other knowledge management practices do teachers engage in?
2. How do different forms of knowledge representation support teacher-learning and pedagogical-practice?
3. What are the functionalities of the knowledge-management system that support teacher-learning and pedagogical-practice?
4. What are the attributes of a knowledge-management system that support organisational or expansive learning?

In phase 1 of the study, 113 teachers participated in focus groups to identify problems with existing systems that were used for teacher-knowledge sharing. The outcome of this phase indicated that the existing systems were inadequate, and that teachers endorsed the development of a new system that would not only enable the sharing of system-specific repository materials, but also would enable teachers to collaborate with colleagues who were outside of their existing professional networks. Teachers believed that such a system would be beneficial to their role and prevent duplication of effort across schools. Whilst phase 1 teachers accessed repository

materials from a wide variety of on-line professional sources, there was no active use of Web 2 technology to collaborate directly with colleagues.

During phase 2, a number of the sites, identified through phase 1 and through the literature review, were evaluated by 18 users, and analysed and preliminary design principles developed for an effective knowledge-management system for teachers. The presentation of material in both case-study form and as best-practice statements was also tested for user preference as a learning tool. The Technology Acceptance Model was used for the analysis of results, and several design characteristics additional to web-based heuristics were identified as being unique to a knowledge-management system. The outcomes of phase 2 affirmed the proposition that ease of use heuristics needed to be satisfied, to encourage teachers to use or contribute to a knowledge-management system.

A prototype was developed in phase 3. The first prototype was not subject to iterative development as user feedback indicated, that ease of use criteria was not met, and that the prototype did not offer any advantages beyond the existing tools available to teachers. A system decision to abandon further development of the prototype was made. A second prototype was then developed using the Google Plus platform. The second prototype met the ease-of-use heuristics. This allowed further examination of criteria related to perceived usefulness, and in particular an examination of the antecedents to perceived usefulness, as they related to a system for teacher knowledge-management and collaboration. The outcomes of the user trial with implications for the development and implementation of a model for on-line teacher knowledge-management and collaboration, are described within the following thematic areas:

1. Teacher Professional Identity
2. Knowledge and Collaborative Learning for Teachers
3. Connectivity and Learning
4. Espoused and Actual Values
5. Activity Theory and the Impact of Culture
6. TAM and Design Heuristics
7. Innovation Adoption in Organisations

9.3 Discussion across Themes

9.3.1 Teacher Professional Identity

Ingersoll and Merrill (2011) highlight the confusion and controversy surrounding the debate about teaching as a profession. This debate is focused on the definition of professionalism as either a function of skill and knowledge acquisition or alternatively as a function of working conditions of teachers. However, Ingersoll and Merrill (2011) do not support strongly these approaches. Instead they have identified a range of attitudes and dispositions that individual teachers hold towards their work that are indicators of the degree to which teacher professionalism has advanced. In analysing these indicators that include: perceptions of specialisation, authority over decision-making, and perceptions of prestige and social-standing, Ingersoll and Merrill (2011) conclude that teaching is still in the process of reaching full professional status. This research indicates that the lack of a professional community in turn impacts on the ability of teachers to participate in self-initiated

learning, particularly when that learning is based on reflective practice or learning through peer reflection and collaboration. The link between teacher professionalism, professional identity and learning is described below.

One of the indicators of a profession is the importance given to specialisation (Ingersoll & Merrill 2011, p190). Specialisation is seen as necessary in order to ensure that the level of skill, training and expertise meets the needs of the “client”. This research indicates that the structures and recognition of individuals favoured by schools continue to be linked primarily to power and authority and hierarchical positions of supervision as opposed to the specialist who has recognition due to specific deep expertise. During the trial this may have contributed to a lack of motivation toward professional growth and development. Further, the language from the hierarchical “experts” demonstrated that they considered teachers to be semi-skilled and in need of improvement by being sent to professional development. For example, the language used by the KLA coordinators was of scarcity and deficit, e.g. “it would have to be obligated ... for a number of teachers to attend if you want the majority. You will get a minority who would do it just because they want to share and they’re interested” (LC); and for teachers, the language was of control and getting it right, e.g. “from a teacher’s perspective, you just get frightened”, (ML) when referring to participation in on-line professional development. Teachers demonstrated a reliance on the structure of in-service programs in order to support sharing, and a reliance on the KLA “experts” who would comment on program development or tell a teacher “you should look at your current practice and what you need to do in order to improve” (JC), rather than individuals who are motivated to deepen their own specialty and training. The impact of this was that teachers in the

trial referred to prescriptive and uniform processes, and demonstrated a pragmatic compliance when it came to their professional learning and development. Ho, Au and Leung (2001) discuss professionalism as having three latent factors: intrinsic, extrinsic and core self-evaluation. The feedback from the trial indicates that the self-evaluation factor, comprising self-esteem and self-efficacy, was structurally absent among the teachers and that teacher professionalism was, accordingly, negatively impacted.

The model of the KLA leader as the residential expert and the tutor who needs to be accessible to teachers, came through very strongly in terms of the professional identity of the school leaders, as opposed to leader behaviour that would support teacher reflection, namely coaching and developing reflective practice of others. There was a view that the KLA leader has the power and the knowledge: (JC) “they contact me and ask me and it makes me feel valued as well”, and a sense that if the co-ordinator is away, then nothing happens. At the same time, there was evidence that teaching is a profession of opinion, where having something to say on the topic is expected and which therefore contributes to a sense that teacher activities are judged by peers and colleagues.

Ingersoll and Merrill (2011), describe a professional as a person who has substantial authority and a large degree of self-governance. This was not evident through teachers in the trial. Instead, those who have positional power i.e. the KLA coordinators and the school leadership team, were viewed as being most knowledgeable about the work, despite the fact that KLA coordinators claim that they are primarily concerned with issues of compliance including curriculum

compliance, assessments and standards. Overwhelmingly the discourse was of teachers who lacked any real power or influence within their school settings.

There was a strong reliance by teachers on the power and authority of the executive structure within the schools. This was evidenced in a variety of ways from: reliance on principals to create school linkages; the manner in which KLA heads and executive “push” or “force” teachers to share resources; teachers reporting feeling supported when being directed to attend a professional development program; and direction being given from the central office regarding what is a priority.

The reliance on external “power and authority” was also evidenced in the fact that all of the changes teachers referred to within their school were externally driven – namely Backward Design, Literacy the Next Step, and focus on literacy. Despite these interventions there appeared to be no internalisation of these interventions in relation to teacher practice. The predominant discourse regarding goals indicated that teachers were “told” the goals through a process of informing and communicating. There was no evidence of goals being internalised by teachers and incorporated into teaching practice. Dinham (2008) describes this style of leadership as authoritarian leadership. Authoritarian leadership creates a high degree of dependency, low risk-taking and low innovation. The challenge, as is discussed below, is to create what Dinham (2008) refers to in his leadership typology as authoritative leadership. The characteristics of the authoritative leader, particularly in relation to the professional growth of teachers, is to create a culture whereby feedback is provided, professional learning inside and outside the school encouraged and valued, and staff (and students) developed to be competent, assertive and self-regulated (Dinham, 2008, 71).

A third characteristic of a profession relates to prestige or social standing. Professions are high status and high prestige occupations that are respected. Ingersoll and Merrill (2011) report teaching as being middle-ranked against professions such as doctors and lawyers, however the teachers in the trial did not reflect this. (JC) stated “something has to change in society because society looks down on teachers as well”. The language of the teachers expressed lack of confidence, fear of being judged, and of being under surveillance by others. The strong emphasis on hierarchical structures and the corresponding perceptions of power and authority residing in the KLACs reinforces the teacher perception that they are constantly being judged and controlled.

Jacobson (2009) examined professionalism through the link between extrinsic motivation factors and the effect on intrinsic motivation and performance. The model proposed by Jacobson (2009) demonstrates a link between extrinsic motivation factors, the degree of professionalism and the impact on intrinsic motivation and performance. The link is demonstrated diagrammatically in figure 15 below, and is based on a hypothesis examined by Jacobsen (2009) that the more extrinsic motivation factors are experienced as controlling vs supportive, the more internal motivation is crowded out or in, with a corresponding impact on performance, in which “performance” for the purpose of this trial was defined as evidence of teachers voluntarily participating in and contributing to on-line learning and collaboration.

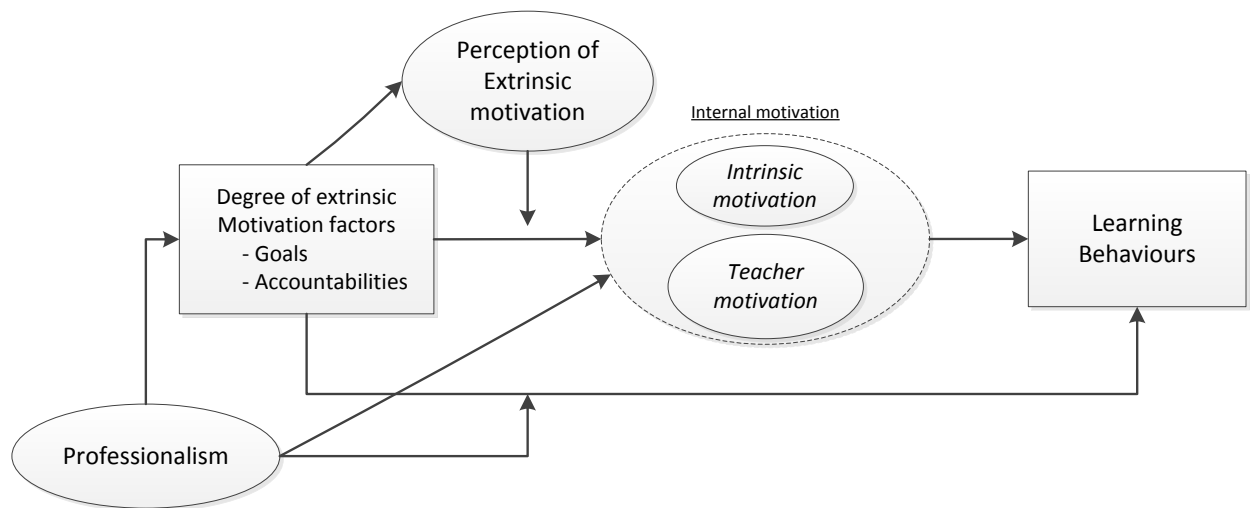


Figure 15: Adaptation of Theoretical Model by Jacobson
(www.akf.dk/psm_en/papers/c_jacobsen_projdesc_01.pdf/, 15)

The link between internal and external motivation was also examined by Ryan and Deci (2000). Building on their (1985) Self-Determination Theory, Ryan and Deci (2000) suggest that there are some types of extrinsic motivation that can support learning, particularly when the goal is self-endorsed and “thus adopted with a sense of volition” (p55). Self Determination Theory focuses on the social and environmental factors that will create motivation for learning. Understanding these factors is important, not only because it goes in some way to understanding the behaviours of teachers during the trial, but also because it offers a lens to examine the teachers’ suggestion that if they were given time and expected to contribute they would do so. Ryan and Deci (2000) argue that intrinsic motivation cannot always be relied upon to foster learning. Whilst emphasising that factors such as communication and feedback can enhance the intrinsic motivation of individuals because they can contribute to an individual’s feelings of competence, extrinsic motivation through identification and integrated regulation may also enhance learning behaviours.

The data from the trial demonstrated the interplay between the external motivators, the impact on intrinsic motivation and the type of learning that was preferred in the school communities involved in the trial. In the trial schools, goals were extrinsic and related primarily to improvement in student outcomes as measured through external examinations. This approach represents what Ryan and Deci (2000) identify as external regulation, and is the least autonomous of the external motivators and least likely to promote the teacher learning behaviours that were encouraged. As discussed in chapter 8, teachers universally expressed a personal and professional alienation from the goal of boys' literacy that was being promoted by the school leadership.

There was some evidence that teaching was exam-driven, with discussion across two of the schools of prepping the students for exams. In situations when results didn't reflect well, the discussion was about changing the assessment task and not about changing the pedagogy, even though in the same context, improvement in results was seen as "evidence on what's happening in the classroom". Ryan and Deci (2000) would describe this as introjected regulation, with teachers describing feelings of pressure to meet these external expectations, and at the same time used language of low self-esteem and professional worth. There were no goals explicitly related to teaching practice, nor evidence of discourse relating to the way in which teacher practice supported outcomes, and accordingly no evidence of either teacher identification or integration of goals – the two types of extrinsic motivation that can, under appropriate conditions, lead to volitional behaviour. The evidence that teachers relied upon in relation to school goals was therefore about "looking good" in relation to the achievement of improved student results, with no discourse on the way in

which that was achieved. The goal was not something that was internalised, but was something that was communicated to teachers.

Teachers remained very reliant on external validation of their practice and were not able to articulate either an internal frame of reference and reflection or an intrinsic desire to be a more effective practitioner. (JC) stated “I’ve constantly got to talk up the staff and say that you are fantastic compared to other schools because they’ve always got the view that they are not good enough”. The sense of teacher identity and low self-efficacy came through repeatedly, “ that sense of self-worth ... stopped them being able to put things up there”.(JC) The identity of the teacher as a professional seemed strongly aligned to the need to be successful or at least perceived to be that way.

(LC) spoke about making use of the prototype obligatory, in order to encourage use of the site. She spoke about only a minority of teachers wanting to share with others “just because they want to share and they’re interested”; (NL) about mandating time for teachers to contribute; and (PS) about the need for schools to put days aside for teachers to participate in on-line activity. The extrinsic motivators that operated within the trial schools appear to have a direct negative impact on the intrinsic motivation of the teachers who wanted to be reflective learners, and the suggestion by teachers that making participation obligatory would not of itself change the nature of the motivators. As is discussed below, the psychological need of teachers for feelings of competence is paramount and the development of school culture to provide supported challenge, promote feedback, exercise professional autonomy and leaders for learning (staff).

Anonymity in professionalism was strongly expressed as part of teacher identity. This is discussed further in section 9.3.3 re beliefs, but essentially would appear to be linked to fear of failure, anxiety in learning, and a culture in teaching that appears to be focused on an externalised view of “getting it right” and being successful. These concerns, that go to the fundamental issues of feelings of competency, are operating directly against teacher self-efficacy and motivation to learn and undermine another of the basic characteristics of professionalism, the participation in continuous learning and improvement (Ingersoll & Merrill, 2011). There appears to be a fear of trying new things “I might be judged” (LC); (ML) “you’ve done it wrong is the assumption”; “we all don’t want to be the person where it didn’t work” so that ironically whilst teaching is a collective activity in relation to outcomes for students, practice remains privatised. Teacher (ML) referred to her study at university and the experience of on-line posting in language that reflected fear and anxiety, and that spoke to a level of voyeurism in the on-line environment “the level of surveillance, like everybody is just watching each other trying to figure out who’s ahead and who’s behind and that sort of thing”.

Teacher (JC) used an attack/combat metaphor, as she described technology, and specifically Web-2 tools and cloudshare, as an “arsenal we’ve got available to us to enable (teachers) to blend content with strategy and activities”. The need to be in control permeated the entire discourse of (ML) – “ in a meeting ... I feel as if I can manage the impressions of others”. (ML) spoke about the need to “guard against” poor assessments being made of individual teacher practice. (LM) talked about the people who design and the people who put into practice, and the need to guard against “the ones who command it and the ones who are doing it”. The language

used by the teachers is suggestive of a profession and individuals who feel besieged and under threat, and perhaps this doubt or lack of trust has impacted on the individual and organisational conduciveness to learning. This aspect of the profession of teaching has important implications for the quality of teaching and learning.

9.3.2 Collaborative Learning for Teachers

The outcome of this study demonstrates that collaboration and learning are optional extras in the industrialised model of education and schooling. The predominant model of teacher professional development within the trial schools continues to be off-site and separate from the day-to-day realities of the teacher in the classroom. Teacher learning as described in the trial continues to be an individual activity with little attention or encouragement provided within schools for collective learning. The word “detached” was repeatedly used during the dialogue – both personally and in reflecting on a curriculum that is seen as being detached from the global world. This was in direct contrast to the espoused view that collaboration was a way to de-privatise teacher practice, seeing other ideas, other ways of working, other ideologies and teaching practices. This detachment has particularly significant implications, given the convergence within education of common approaches to teaching and learning such as global comparisons regarding student outcomes and the fast pace of technological change that requires the ability and willingness for teachers to access highly contextual and relevant lessons informed by current content and pedagogical knowledge.

One of the most critical issues raised by this study is the understanding within the individual, school and system about what constitutes effective learning for

teachers, and the role of teacher collaboration. There appeared to be little understanding or distinction between the development of teacher knowledge and teacher professional practice, with the focus primarily on the sharing of teacher knowledge in its explicit forms (programs, resources, lesson plans). (JC) expressed this dichotomy when she stated “there’s a slight change of focus with teachers from being content-based ... to them trying to work out how to incorporate strategies into their content because **you can’t do both**”. Interestingly (JL) had responsibility within the school for teacher professional development. Within the domain of teacher knowledge, teachers had an external focus – their classroom and their students – and were primarily occupied with gathering information that would assist them to deliver lessons to that external audience. Whilst individual teachers sourced materials from a range of on-line environments including on-line professional associations, there was no evidence of self-initiated collaborative activity in the domain of teacher professional practice. Where such activity was evidenced it was either in the context of formal course requirements associated with on-line learning modules, or the dispersion of practice initiated in face-to-face meeting by KLACs, who acted as filters around what information would be transferred from beyond the school boundaries. There was little evidence of a focus on the links between particular teaching activities and outcomes associated with positive impacts on students.

Research has demonstrated the importance of the participating teachers’ practice context to assist teachers to translate theory into locally adapted applications (Timperley 2008, p10). However, the sole focus of the teachers on local context, in which the specific demands of particular students within specific communities are being addressed, has demonstrated in this study to be an impediment to a teacher’s

ability to learn through reflection, generalisation and application of experiences of teachers in other schools. There was evidence that “context” was considered in such a narrow sense as to mean “identical” and therefore there was little practical interest in the approaches taken by others. (ML) expressed “we’re in a unique position here” when describing her school’s literacy goals.

There was no evidence of individual or shared reflection on teacher professional practice. This was not just in the on-line environment, but characterised the face-to-face meetings that occurred within the schools. Collaboration was described by teachers as the sharing of resources and not as a process by which teachers could work with others to understand how existing beliefs and practices impact on student learning and to thereby change practice. There was no evidence of teachers thinking about alternatives or of an awareness of learning gains made as a result of changed teaching approaches (Timperley, Wilson, Barrar & Fung, 2007).

Teacher collaboration was possible when the material shared was positive in its nature, and this presents a major challenge to teacher reflective practice. Teacher (LC) expressed the view that shared reflection is optional unless it forms part of a CEO-mandated activity within professional development. Without formal professional development, sharing was limited. There was an expressed reluctance on the part of teachers and KLA heads to enable learning that was outside the “comfort zone” and which exposed teachers to a risk of being vulnerable when strategies failed. Learning was characterised as “getting the right answer” and this inhibited the willingness of individual teachers to participate in face-to-face or on-line learning activities that would leave them exposed to professional criticism.

The perceived specialness of the school/context served to reinforce the privatisation of practice. There was confusion between sharing (collaboration) and showcasing, with most teachers describing the latter, when asked about collaboration between schools. This was also reinforced structurally, with the “teach meets” which were specifically designed to provide teachers with a short time segment (5 mins only) to demonstrate to others a resource or approach. This again reinforced the audience as a passive recipient of information. The meeting structure created barriers to individual or group reflection and the decision to adopt a demonstrated strategy is an individual one. As discussed above, there is also evidence of the private nature of teacher practice and teacher isolation driven by systematic structural isolation of the school and discrete KLA areas. The process of KLA specialisation and the appointment of leaders who then are seen by others to be the subject “experts” fragments the responsibilities of teachers around a number of key areas including responsibility for their own development; quality control around curriculum and relationships with parents, etc. As a result, the helplessness that underpinned teacher comments was a reflection of a pragmatic compliance to the many agendas that were imposed through the KLA leader, the school hierarchy, and the many other agendas that were identified as coming from external sources. At the same time, in the absence of these structures, teachers were unable to traverse the professional domain, as evidenced by the lone teacher in a subject not feeling connected with teachers of other disciplines (JC) and a view from the same teacher that it was difficult to talk to teachers about what could be termed “meta-strategy” as “teachers tend to be quite entrenched in their own subject area”.

9.3.3 Connectivity and Learning

In chapter 3 the theory of connectivism was discussed in relation to its possible application to the development of a knowledge-management system for teachers. In that chapter, the concept of a knowledge-management system as a self-organised system, in which teachers contribute and learn from each other, in which participation was voluntary and autonomous and in which learning was both emergent and emerging, (Williams, Karousou & Mackness, 2011), was predicted to be possible with the use of Web-2 platforms. The results however did not deliver this outcome when “learning” is defined as being something other than transferral of objects. There is no doubt that teachers actively engage in connecting to information sources, maintaining connections to facilitate access to those sources, and engage in a process of evaluating that information for its usefulness to their own context. However, neither through the prototype, nor through their existing sources is there any evidence to suggest that teachers are using networks to transfer, build or make understandings regarding their practices. In this respect, the criticisms of Bell (2012), Williams, Karousou and Mackness (2012), Kop and Hill (2008) and Barnes and Tynan (2007) are supported, namely that networking does not necessarily transfer to learning. The work of Mackey and Evans (2011) in support of connectivism as a learning theory may have more to do with the context of the particular network that formed the basis of that study, which was as part of a professional development program. Therefore the study may be more aligned to design principles associated with e-learning and motivation than about the formation of self-motivated learning networks, networks per se. Tschofen and Mackness (2012, 129) suggest that “a potentially unfettered network environment may work best for adults ... or the most experienced learners and perhaps those with a large amount of traditional education

as a background”. This study suggests however, that even among educated adults (teachers) there is a learned helplessness and lack of maturity with respect to learner autonomy. Further, this study suggests that teachers as learners are neither motivated, equipped nor willing to take advantage of the options of social networking in a connectivist environment for the purpose of deep learning.

Kop (2011) has looked at connectivism and personal learning environments through the lens of expectation for mutual obligation and support. Ryan and Deci (2000) discuss the concept of connectivism as part of self-determination theory and the concept of relatedness. Boitshwarelo (2007) and Boitshwarelo (2009) examine connectivism and psychological autonomy and its relationship with behaviours, “autonomy concerns acting from interest and integrated values”. These studies recognise that the “nodes” for learning and connectivity are not sufficient of themselves, but must be considered in a broader cultural context. This is discussed through an examination of the culturally espoused values, that predicted the need and the use of the prototype, as compared to the actual observed behaviours, that have been analysed to infer the actual values in action.

9.3.4 Espoused and Actual Values

Culture is defined as a pattern of shared basic assumptions learned by a group as it solves its problems ... and is therefore taught to new members as the correct way to perceive, think and feel in relation to these problems (Schein, 2010, 18).

Schein (2010, 16) defines culture as having the elements of structural stability, depth, breadth and patterning or integration. In the case of this study, some inferences can be drawn regarding the culture of the pilot schools. Against the elements defined by Schein (2010) it appears that the identity of the teachers is primarily as teachers of

their class, therefore the primary focus of the teachers is on lesson delivery and the lesson content that assists in that delivery. This appears to be deeply embedded, with school structures and processes and tools organised around the class and faculty, rather than around the profession more broadly and the professional practice of teachers. The breadth of this aspect of the group's functioning is such that there were no examples of teachers across the full study using autonomous collaboration for the purpose of developing professional practice. The only exemplars were of organised activities or of mandated collaboration as part of professional development attendance. Patterning and integration, as an element of culture, is defined as the rituals, climate, values and behaviours that tie the members together, and makes the environment sensible and orderly. In this study, the pattern that emerged was one of inward-looking culture in which a true culture of autonomous professional learning was absent. The prevalent discourse that underpinned the teacher comments mirrored the political discourse of a failing education system that blames teachers, and which therefore drives teachers to being wary of exposing themselves to judgement about practice.

Examining the three levels of culture (Schein, 2010, 24) an analysis of the data that came from the trial is as follows:

Level	Evidence
1. Artefacts <ul style="list-style-type: none"> • Visible Structures and Processes • Observed Behaviour 	<ul style="list-style-type: none"> • Meetings are primarily at faculty level. • Sharing of ideas occurs through the KLA coordinator. • Collaboration is viewed as the

<p>2. Espoused Beliefs and Values</p> <ul style="list-style-type: none"> • Ideals, Goals, Values, Aspirations • Ideologies • Rationalisations <p>3. Basic Underlying Assumptions</p> <ul style="list-style-type: none"> • Unconscious taken-for-granted beliefs and values 	<p>sharing of objects or cooperative development of objects.</p> <ul style="list-style-type: none"> • On-line tools within the school are supported at faculty level. • Teachers rewarded at individual level by results of their students. • Goals were not understood. • Teachers state that they want to share with other schools and that they can see value in greater sharing. • Rationalisation that lack of time and structures prevents this. • Anxiety regarding new learning. • Anxiety regarding professional status. • Fear of failure. • Individual not team outcomes rewarded through recognition.
--	--

Table 21: The Three Levels of Culture (Schein, 2010, 24) as Observed Through the Trial

The inferred cultural paradigm of the schools is outlined in figure 16 below:

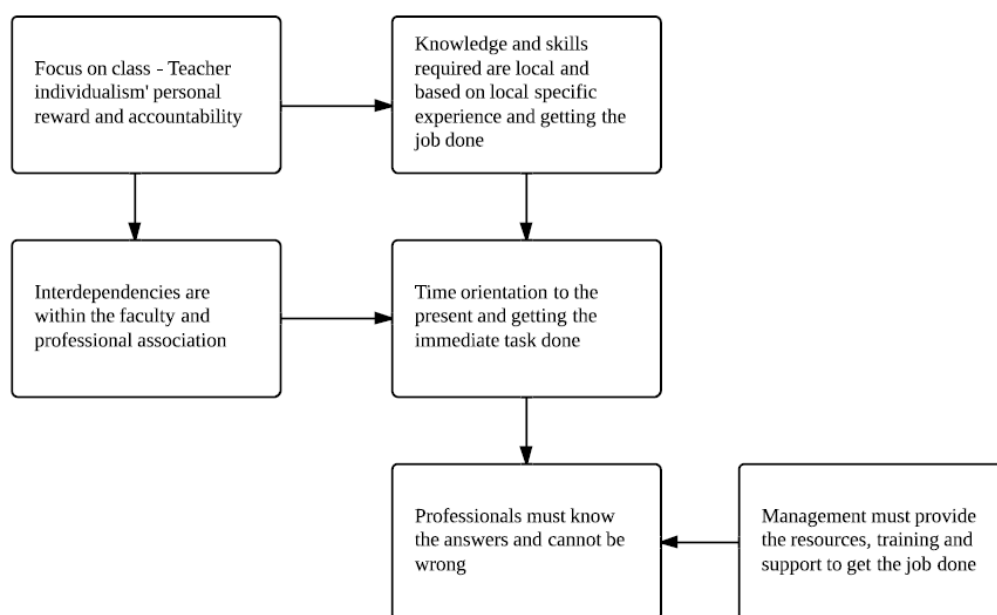


Figure 16: The Cultural Paradigm of Schools Participating in the Trial

The cultural paradigm that was evident in schools that participated in the trial, closely match the operator-subculture described by Schein (2010, p58). One of the challenges of successfully implementing a knowledge-management system is to develop a subculture, in which the focus is more broadly on a global outlook, in which knowledge is valued and in which improvement in professional practice is inextricably linked to the outcomes in the class. This is further discussed in the implications of the study, as issues regarding school culture remain critical in creating environments to support teacher learning and reflective practice. This study suggests that unless it is occurring in the face-to-face environment, there is little prospect of effectively transferring teacher-knowledge management and learning to an on-line environment.

9.3.5 Activity Theory and the Impact of Culture

Activity Theory (AT) builds on the work of Vygotsky (1978) and focuses on the interaction between the mind and activity. Characterising learning as a human activity, it specifically examines the relationship between the learning and the community in which it operates, including the rules and division of labour. It also recognises that systems are characterised by internal contradictions caused by tensions in the components, and that the internal contradictions can cause subjects (learners) to not achieve the object. In this study, a range of internal inconsistencies impacted on the teachers. These included:

- 1) The contradiction between the stated goal of boys' literacy and the actual individual goal of teachers which was not well understood or articulated;
- 2) The stated goal of teacher collaboration was not supported by systematic structures or processes within the school or system. Indeed there appears to be little value or support for collaboration; and
- 3) The lack of understanding of the link between teacher actions and student performance inhibited teacher learning.

There was also a misalignment of the activity system focused on teacher knowledge-management (the prototype) and the activity systems engaged in the introduction of the new e-reporting system and introduction of the new National Curriculum. Both of these other systems were imposed, focused on external measurable outcomes, and were time-driven for adoption. These factors reinforced "rules" of the community that were diametrically opposite to those needed to support a knowledge-management system and reinforced behaviours of dependency,

compliance and external validation. They did not support the creation of internal reflective practice within teachers, ability to operate within ambiguity, and ability to self-identify needs that would ultimately change pedagogy. It was therefore evident that in this study, the internal contradictions were so great, that there was no evidence that the tool (the prototype) changed the process or that teachers were changed by the process.

9.3.6 Technology Acceptance Model (TAM) and Design Heuristics

TAM has been accepted as a theoretical model to predict the use of new technology by users, (Lee, Cheung & Chen, 2005; Liu, Liao & Peng, 2005; Pituch & Lee, 2006; Saade, Nebebe & Tan, 2007; Park, 2009). Davis, Bagozzi and Warshaw (1989) conducted a longitudinal study with 107 users to measure intention-to-use system after the introduction and then 14 weeks later. There was a strong correlation between reported intention and self-reported usage. Selim (2003) found that the relationships between perceived usefulness, and perceived ease of use were good determinants of intention to use (web-based learning). Venkatesh and Davis (2000) introduced TAM 2, and identified additional variables that act as antecedents to perceived usefulness: subjective norm; image; job relevance, output quality and result demonstrability. TAM 2 has been found to operate in mandatory and voluntary environments.

During phase 2 and the first prototype of phase 3, the *ease of use* criteria for an on-line knowledge-management system were developed and tested. These are described in the design principles below, and during the trial were validated, with the exception of the requirement for contributors to identify themselves when making a contribution. Whilst teachers in phases 1 and 2 recommended that contributors

should be identified, the evidence from teachers during the trial contradicts this. Possible reasons appear to relate to fear of being judged, and fear regarding the permanency of their digital footprint. This indicates that particularly during the early stages of adoption of a new system, anonymity may contribute to an environment in which teachers more freely participated. However, anonymity on its own may not have been a sufficient condition for the encouragement of teacher contributions that were reflective and learning-orientated. Further, the study demonstrates that unless the *ease of use* design criteria are met, teachers will not engage with an on-line system.

Teachers who participated in the study all indicated their belief that a knowledge-management system would assist them in their job. Whilst the prior experience of teachers had primarily been with the sourcing of materials for their class, the expressed benefits of a system were seen to include the opportunity to broaden the professional network and to engage through Web-2 tools in collaborative practice, problem-solving and the sharing of professional experiences.

However, despite TAM predicting that there would be use of the prototype, it did not translate to actual use. As discussed above, the system and learner characteristics, identified by Pituch and Lee (2006) as potentially impacting on perceived usefulness and perceived ease-of-use, appear to have mediated the actual use. The social norm antecedent (TAM 2), described by Grandon, Alshare and Kwan (2005) as the social pressure to perform or not perform the behaviour, which in this instance is reflective learning, was similarly unsupported within the culture of the schools. These findings support the position of Park (2009) that perceived use and

actual use do not always align, and that actual use reflects the need to look at individual context, system context, social context, and organisational context.

9.3.7 Innovation Adoption in Organisations

There are two distinct phases to the adaptation of an innovation within organisations (Gallivan, 2001), a primary phase associated with decision to adopt an innovation and a secondary phase associated with organisation assimilation. Key elements of the process are:

1. Primary Adoption: managerial intervention; subjective norms; facilitating conditions; and
2. Secondary Adoption: organisation assimilation and consequences.

The application of the innovation adaptation model would have predicted that the launch and trial of the prototype would have resulted in users adapting their practices, particularly given the support of the trial by the school principals and the stated commonality of purpose and desire to collaborate between schools. However, as has been discussed, this did not occur. The importance of the subjective norms to the primary adoption was singularly the most critical aspect of the adoption of a knowledge-management system.

As discussed in chapter 8, all of the teachers involved in the trial were familiar with the Google platform, and were required to use it within their faculty. In not recognising the prototype as a further innovation, the researcher did not specifically plan for or address the elements, other than the subjective norms that may have increased teacher adoption rates. Whilst the principals of the schools had made the decision to trial the prototype, and whilst there was technical assistance

within the school for users of the Google platform, there was not specific and targeted action from principals in stressing the importance of the prototype to assisting teachers in the achievement of goals regarding boys' literacy. It was also clear that the facilitating conditions for adoption, in particular a culture of self-initiated learning among teachers, was not present. These and other issues referred to earlier, prevented the prototype from achieving primary adoption.

9.4 Implications

Having determined through phase 1 that a connective learning environment was desired by teachers for professional learning and collaboration, this study sought to develop an on-line learning community using a process of co-developing, testing and implementing a prototype system with a target group. The prototype was developed in a manner that was consistent with the theories of situated cognition and distributed learning and was designed having regard to the heuristics for web-based interfaces. The on-line learning space was in the form of a site that incorporated capacity for repository items, and several learning spaces that were designed to connect teachers through Web-2 tools in ways that would support learning around teacher professional practice. Through the course of the study, requirements in the form of additional design elements for usability were developed.

The emergence of Web-2 technology has relegated knowledge-management systems as discrete entities to being a thing of the past (McAfee, 2006). Instead, as was borne out by the results of phase 1, teachers currently use channels such as email and person-to-person messaging, or platforms such as intranet and information portals to support the generation and distribution of information. This study, which involved the design and trialling of a platform to support teacher-collaboration and

knowledge-sharing was not adopted by teachers despite cooperative design input and stated intentionality to be used.

Pace-Marshall (2006, p16) states the need for new models for generative learning.

Generative learning is a purposeful, exploratory and creative process of discovery. It is a natural goal oriented and continuous process of constructing meaning through pattern formation and active and experimental engagement in complex issues and problems... deep understanding and expertise developed through immersion in complex questions and messy problems that require continuous practice of critical and creative thinking.

There is a strong sense coming through from the data analysis that system-prescribed agendas and solutions restrict the capacity for teachers to learn and develop – instead this creates a culture of learned helplessness as articulated by (JC): “we do not want to do everything the way the CEO says because sometimes we come up with a better solution but why isn’t our better solution acceptable”? It was clear from the trial that despite the range of interventions implemented in the participating schools, many of the characteristics of a professional workplace as defined by Ingersol and Merrill (2011), were not evident. Often teachers exhibited a learned helplessness when it came to their own learning and a reliance on extrinsic factors to motivate practice.

McLure-Wasko and Faraj (2005) discuss knowledge-sharing in open-access on-line virtual communities of practice and determined that individual motivations

and social capital considerations are the main influencers on knowledge-sharing. This study demonstrated how difficult these conditions were to achieve within and between schools of the trial. Not only is there no perceived advantage to teacher professional reputation in participation, such activity is not actively promoted in the schools. Even in the low-risk area of sharing of repository items, there is seen to be potential negative consequences to reputation by sharing. This contrasts sharply with the self-reported activity of teachers within professional association networks that cover a state or national community of teachers. Self-reported activity in this domain would suggest that the relative anonymity of these associations enables teachers to share more easily, and these associations meet what teachers see as their primary need, which are lesson plans and classroom resources.

Significant change would need to occur in the social climate of the workplace, the community, its rules and division of labour, before new forms of learning could be structured and the potential that was described through phases 1 and 2 realised. The socio-cultural environment was not conducive for on-going collaborative and contextual learning. Lack of culture for peer collaboration and innovation were identified as inhibitors to teacher knowledge-sharing: (JC) “it would have to be a culture change of the expectations of teachers and then the structures that are there to support teachers, to change those to allow those changes and expectations to happen.”

The culture of the teaching profession, as a highly individualised activity, and the basic assumption behaviours demonstrated by teachers in their fear of judgement and fear of failure was evidenced in the high anxiety that a number of teachers within the trial expressed regarding their willingness to share either face-to-face or on-line

with their colleagues. The human need for cognitive stability and the cognitive defence mechanisms that can be associated with deep learning would indicate that critical attention needs to be paid to the culture of schools and their ability to create safe and supportive environments for teachers, before any further attempt be made to support autonomous on-line learning and knowledge-sharing. Teachers referred to: the meaning/understanding of criticism (JC); self-reflection vs self-deprecating (JC); and the society view of teachers (JC), and confidence (JC).

It would also be critical for school structures to change, as the current systemic structures interfere with creating a culture of learning, focus on external artefacts and create frustration for teachers: (JC) “I’ve got my resources, I have them on my Google site for my students. I then have to, as a school-based thing I have to have evidence of what I did. So I’ve got to go on my KLA Google site and record what I did and why I did it and then ... then I have to build it into my programs and then the CEO comes out and they check that I’ve got everything where it needs to be and then we have NAPLAN and then we get judged on our NAPLAN results and all that seems quite discordant”, “All these different things they expect me to do and I’ve got to do it in a different way of each – different reasons for different people and different levels of the organisation”. The structure in secondary schools, where teachers work within and are aligned to KLAs acted to further restrict and privatise teacher practice.

Schein (2010) described the process of cultural formation as one of external adaptation. In relation to the study, the elements of external adaptation as they were expressed by teachers in the trial and as they would need to be to support teacher knowledge-sharing, are described in the table below:

Element	Evidence from Trial	Required changes
Mission and Strategy	Core mission is defined around student education.	Teachers have a personal goal regarding on-going professional learning (knowledge and practice) that clearly and explicitly links their own knowledge and practice to student outcomes.
Goals	The primary goal around boys' literacy was ill-defined, and not well-articulated by teachers.	Each teacher clearly understands the goal in relation to their own role and implications for both knowledge and practice.
Means	Structure, division of labour. Reward and authority systems support the goal.	Teachers are expected to demonstrate on-going professional learning and reflective practice with peers. The structural norm of KLA coordinators filtering information ceases and all teachers are required to work beyond the boundaries of their own school. Move to a mix of face-to-face and technology – embed reflective practice.
Measurement	Measures focus on student outcomes and teacher outcomes for the class.	Measures of how the group delivers learning and teaching and growth in teacher professional practice are

		required. (CL) – we need to get some important messages out – “Its OK to be wrong; Its not just the teacher teaching the subject who wants the feedback; Its OK to publish unfinished work”.
Correction`	Strategies that are introduced if the goal is not met are system (external) driven.	Strategies include teacher-reflection and teacher-initiated action-learning cycles.

Table 22: The External adaptation Factors for Culture (Schein, 2010, 74)

The cultural assumptions that underpin the changes that would be required challenge the existing arrangements within schools around structure and hierarchy, around beliefs of what should be measured (not just student outcomes), what gets rewarded, and issues of identity (that the group to which the teacher belongs is expected to be broader than their faculty, school or professional association). Fundamentally however, individual teachers would need to change and the formal system of status and hierarchy through which teacher learning gets channelled, would need to shift so that each teacher could contribute ideas around knowledge and practice and feel comfortable when others test and challenge it. The current cultural norms around teacher-learning, based as they are on influence, authority and power, serve to leave teachers free of the anxiety associated with deep learning and the testing of their tacit beliefs and assumptions around learning and teaching, but in doing so, remove the capacity of teachers for reflective and deep learning, and the capacity to do so in association and collaboration with colleagues.

Underpinning these changes is the need to address teacher identity or self-belief. The social discourse regarding the “failing” school system, along with concepts of academic elitism among teachers and the culture of judgement have resulted in a dominant discourse among teachers of the trial about success and failure and professional worth. Negative outcomes, rather than being attributed to learning and professional development, are predominantly attributed to failure. The need for schools to create safe and secure environments not only for students but also for teachers as learners is critical. The critical value of deliberate role-modelling, teaching and coaching to achieve this shift needs to be recognised.

The changes that are needed for the implementation of a knowledge-sharing culture (whether face-to-face or on-line) have more profound implications than those to which this study was directed, for without the change, many of the current educational agendas regarding quality teaching and learning will not be achieved.

Design Principles

This study demonstrates that teachers already access connective learning and that if the only intention is to enable teachers to share objects between colleagues, there is no need for any further development of systems to support this outcome. Teachers throughout this study reported regular use of professional association sites and other web resources in order to gain access to the materials that were required to deliver teaching to their classes. There is also no need to develop further systems to assist teachers in the organisation of their work as all of the faculties who participated in the study had interactive sites where-by teacher notes, assessment tasks and noticeboards could be posted.

This study suggests that the organisational maturity was not present for knowledge-sharing activities – either face-to-face or on-line. The significance of the study is that three attitudes or beliefs would need to change:

1. The belief that teachers have about self-learning – not only what it is but what is involved;
2. The belief that teachers have about context – that context is important to understand another setting and the likely transferability of knowledge or practice, but also that learning is a process of reflection, generalisation and application; and
3. The belief about whose responsibility it is to learn – from passive to active learners exhibiting intellectual curiosity.

The area of need identified by participants to this study was around on-line teacher collaboration. During this study, the Technology Acceptance Model was used to develop and inform a prototype. The Ease of Use principles and the Perceived Usefulness principles predicted that teachers would have used the prototype. The fact that they did not, demonstrated, in accordance with Activity Theory, that the structure of the communities within KLAs, and the rules and divisions of labour all acted on the system in a way that prevented learning from occurring. The outcomes of the trial demonstrated that there was significant difference between the artefacts that were visible around knowledge-sharing in the pilot schools, and the espoused vs actual values that could be inferred from the comments of participating teachers following the trial.

The design principles therefore fall within three categories that are sequential in the development of a successful knowledge-management system for teachers.

These are:

1. Develop a culture for knowledge-management that encompasses teacher professional practice and which extends beyond the boundaries of faculty, association and school;
2. Develop communities, rules and structures that support knowledge-management both in face-to face and technology-supported environments (refer Activity Theory); and
3. Only then, when the pre-cursors described above are in place, would the design principles for an on-line environment be relevant.

Each of these is described below:

1. Develop and Embed a Culture:

Provide reflective opportunities within schools that are both challenging and supportive.
Establish a culture of self-responsibility for learning.
Deliberately role-model, teach and coach for reflective learning re practice.
Deliberately embed the skills for learning through generalisability of practice and pattern-making, and then challenge for application to local context.
Embed expectations and recognition for teachers working beyond the boundaries of their own school.
Create conditions of psychological safety to overcome learning anxiety.

<p>Create deliberative opportunities for all staff (not just leaders/KLA coordinators) to share in face-to-face meetings with colleagues from other schools to develop collaborative learning skills.</p>

Table 23: Design Principles for the Development of a Culture for Knowledge Management

2. Develop Communities, Rules and Structures that Support Knowledge Management

Community – The understanding of community among teachers needs to be broadened beyond KLA areas to include whole-of-school and beyond the school.
<p>Rules – rules for reflective and collaborative learning need to be established, but in a way that promotes teacher autonomy and teacher self-initiative. These include:</p> <p>Establishment of professional learning communities within and across schools; modelling collegial practices for evaluating and sharing best practice in teaching strategies and professional knowledge and practice; critically reviewing research on best practice in teaching and learning to assist colleagues to further develop their teaching expertise; and initiating strategies for developing a climate for accepting and providing constructive feedback and recognition of achievement, including student voice.</p>
Division of Effort – requires re-examination with less focus on hierarchical structures and dependence on hierarchy to lead learning, and on structures that work horizontally with learners and encourage co-learning.

Artefacts – reliance by teachers on artefacts such as lesson plans, programs and resources needs to be balanced with artefacts such as reflective learning journals, case studies and collaborative outputs.

Table 24: Design Principles for Development of Rules and Structures that Support Knowledge Management in Schools

3. On-line heuristics

Teachers throughout the trial expressed their need for an on-line system, the belief that it would make their jobs easier and their intention to use it once developed. Therefore once the conditions for knowledge sharing have been embedded within the culture, the design principles below can be applied to development of an on-line system, with some confidence that they have been refined and tested through the iterative design process.

Design Criteria for Ease of Use (Usability)	Description
	The ability to upload and download materials is critical to the user experience, as is the ease with which connection and interaction with colleagues can occur.
1.Visibility of System Status – user is informed about what is going on.	Design elements such as colour coding act as navigation cues. Information is clearly available regarding user-initiated actions such as uploads and downloads and status of materials. Related materials are located together and easily searchable.
2.Match Between the System and the Real World – system uses user’s language and real-world conventions.	The language used is education-focused and reflects phrases and concepts that teachers use in their day-to-day environment. Organisation of materials matches the structures used in education i.e. subject

	<p>areas and stages of learning. Symbols, icons and names are intuitive within the context of the task.</p> <p>Information is arranged in a logical order.</p>
3. User Control and Freedom – user can select and sequence tasks.	<p>The ability to move backwards and forwards between repository and social functionality is supported. Sharing of materials is logical and straightforward.</p>
4. Consistency and Standards – consistency in words, actions and objects.	<p>The site is clear and consistent. The same concepts and words are used throughout to refer to the same thing.</p>
5. Error Prevention – careful design eliminates errors.	<p>Data input is simple and straightforward.</p>
6. Recognition Rather than Recall – actions, objects and options are visible; instructions visible and clear.	<p>The same colour is used to group different elements; groupings of elements follow a logic that teachers use in their day-to-day work.</p>
7. Flexibility and Efficiency of use – operations allow for different users.	<p>The design caters for user ability ranging from novice to expert.</p>
8. Aesthetic and Minimalist Design – no irrelevant information.	<p>Each screen has a short, clear and distinctive title.</p> <p>Use of spacing, colour, white space and typography provides a pleasurable interface experience to users.</p>
9. Help Users Recognise, Diagnose and Recover from Errors – error messages clear and in plain language.	<p>The help screen is complete, accurate and understandable.</p>
10. Help Documentation – information is easy to find and sets out clear steps related to the task.	<p>Clear instructions provided on how to set up groups and discussions.</p>
11. De-privatisation	<p>Easy access to groups. Contributors named and contactable. However, the choice to contribute anonymously supports individuals who are anxious about being identifiable.</p>
12. Interactivity – interactions and tasks support meaningful learning.	<p>Users are able to connect with colleagues in a variety of ways including through special interest groups, and synchronous and asynchronous chats. File sharing is easy. Information is provided regarding dates of posts.</p>
13. Message Design – information is	<p>Use of icons to categorise information.</p>

presented with sound information processing principles.	
14.Learning Focus	Users identify themselves by name, location and contact (email) to enable further questions and contact to be made. Scenarios are professionally (not socially) located and are relevant to the professional practice of teachers.
15.Media Integration – inclusion of media serves sound pedagogical purpose.	Clips support areas for teacher professional development.
16.Resources – resources necessary for effective learning are provided.	Description of the resources provided includes size, type, and content of the material. An indicator from other users of the usefulness of the document is provided. Materials contain a sense of the context in which the resource was created and used.
17.IT agnostic	Usable on multiple devices. No specific programs required to access materials.

Table 25: Design Principles for the Development of an On-line Knowledge-Management System

Limitations of this Study and Areas for Further Research

The level of self-doubt among teachers in the trial was surprising and in itself, would be enough to drive static and inward-looking teacher practice. Further research on the impact of the political discourse regarding the failure of the education system that blames teachers and how this impacts on self-efficacy could be conducted to determine how this is shaping professional identity, and how this could be re-shaped within local systems to encourage individual and organisational learning.

More detailed analysis of the schools' cultures would be required.

Conclusions that have been made relating to the cultures are inferential from the conversations of the participating teachers and would need to be tested more directly

through observation and cultural analysis. This is particularly important to the understanding of how to create the cultural conditions for teachers to be autonomous learners. The researcher observed that even in those schools in which professional learning communities are established, or opportunities provided for teacher sharing, these are generally driven from the same cultural underpinnings identified in the trial, whereby organisation occurs by the hierarchy (coordinators or other school leaders), and participation is mandated. To that extent, these activities still mitigate against the creation of the teacher as a self- motivated learner.

Whilst phases 1 and 2 and the first iteration of phase 3 of this study were conducted with users from both primary and secondary schools, the final trial of the prototype was across secondary schools only. It would be anticipated that the structural influences within a secondary school, particularly the KLA structure, may have contributed to the significant “silo-isation” (segregation within departments) of the teachers within the trial schools and the inability of the teachers within the trial to express any capacity to generalise their experience or practice to areas beyond their own faculty. It would not be expected that these factors would be as strong in the primary school environment, and further research would need to occur to determine the extent to which different structures would act on the activity system (teacher knowledge-sharing) in a different way. However, given that the patterns of use of Web-2 resources reported in phases 1 and 2 of the trial were not different between primary and secondary, and many of the concerns expressed, identical, it is not anticipated by the researcher that there would have been a significant difference in the outcome.

Conclusions and Recommendation

Throughout the time frame of this research significant external changes have been mandated within the teaching profession, most notably with the announcement that by 2018 all teachers will need to be covered by the National Teaching Standards. Whilst at first glance this would appear to be a catalyst for a shift to individual teacher accountability for professional growth and development, it is evident from this research, which included teachers already captured by the NSW Teacher Standards, that this would not of itself be sufficient to drive the cultural change required.

However, recent developments in NSW public education have flagged the future introduction of increased pay with the achievement by individual teachers of higher professional standards, and a belief within education that this will provide external motivation for teachers to engage in explicit reflective learning and evidence-based practice.

Early work has commenced within the CEO to create the necessary culture to support the individual teacher-learning and development that will be required. Early signs have been promising as to the steps that are required to create the cultural precursors for successful on-line knowledge-sharing and management. These have been:

1. Changing the organisational discourse regarding teacher professional development. The CEO has explicitly adopted as policy the 70:20:10 approach to professional growth and development. Originating from the work of McCall, Lombardo and Morrison (1988), this approach explicitly requires what DeRue and Ashford (2010) describe as mindful engagement – ‘placing the burden of learning from experience on the person in the experience’,

McCall (2010, p65). This has started to shift quite dramatically the compliance approach to professional growth and development, even to the extent of individuals being challenged to leave formal sessions in which they do not feel their needs are being met or to which they are unable to contribute.

2. Formal professional development sessions are structured to enable “fall forward” conversations. These conversations explicitly target the surfacing of “failures” with opportunity to discuss what was learnt and what might be done differently in the future.
3. Mellow, Woolis and Laurillard (2011) state “the education community knows a lot about learning but does not always apply this knowledge to itself”. This was borne out by this research and the trial. Since then, explicit work has been undertaken to develop “learning leadership”, a concept discussed in Childs, Keppell, Brown, Hunter, Hard and Hughes (2011). Consistent with the work of Lefoe et al. (2007), this has involved engaging leaders in formal leadership training around how to identify appropriate learning activities and experiences for their own development; development of practices for deliberate and explicit reflection on experience; and opportunity to transfer the learning to new contexts and situations. Whole-school leadership coaching programs have also been piloted to assist leaders to coach individuals in setting learning objectives, providing experience-based development and seeking appropriate feedback and support. Formal organisational structures have not been employed, and individuals and groups

are encouraged to seek opportunities and connections beyond their own school and region. Senior leaders have been assigned as coaches to schools not under their direct supervision, thereby creating new connections and enabling the expansion of internal professional networks.

4. Changes are currently being introduced to the teacher appraisal process, explicitly requiring reflection against the 70:20:10 framework. Re-badged as Continuous Practice Improvement, this process requires individual teacher reflection against:

70: Learning through solving real problems and learning through new experiences;

20; Learning and developing through others by seeking feedback, engaging in coaching and using peer and student feedback tools; and

10; Learning through structured courses and development.

5. The experience of the trial suggests that as these initiatives continue to shape a new culture within schools, the conditions will be created for an effective on-line system for knowledge-sharing and collaboration. Early indicators are that this is occurring. Late in 2013, expressions of interest were sought for participation in an on-line COP to engage around the higher levels of the Australian` Teaching Standards. Culturally within the organisation, in the past, individuals would have been nominated by their managers to participate. In keeping with the cultural shift that is being created, in this instance volunteers were called for. With no promise of monetary or other reward for participation, an overwhelming response was received from 129 individuals who have elected to participate in the process. An on-line site has been

created that has features for an e-portfolio, a collaborative working space, and has search functionality. Significantly, the site has been structured in accordance with the conversation framework described by Mollow et al. (2011), and participants are able to post evidence around their own practice against the teaching standards and have fellow participants engage as co-learners in providing reflection and feedback that can enhance the ideas and practice of the originator. Early indicators are that engagement in the on-line process is strong without the explicit need for facilitation. This supports the conclusion of Reushle and Antonio (2013) that the organisation may need to play a continued role in facilitating and supporting the formation of frameworks for on-line collaboration and knowledge-sharing, but does suggest that with the right culture, voluntary membership and engagement by teachers is possible.

Final Concluding Remarks

The concept of continued personal and professional growth of every teacher underpins much of the discourse quality teaching. It drives Government agenda's such as the NSW Government's Good Teaching Inspired Learning, and the shift in many state jurisdictions to evaluating individual teacher practice against the Australian Standards for Teaching. Teachers who participated in this research have indicated clearly that they believe they can learn and be supported through the collaboration with colleagues, and learn from sharing of practice with other schools. The development of the prototype demonstrated that teachers will access on-line platforms provided they are simple, interactive and useful, and that teachers connect currently in a variety of ways. However, the research also indicated that perceptions for usefulness for existing platforms remain narrow and are primarily focused on

ability to access lesson content. And this purpose will be more important as education converges and specialisations increase. The findings of this study suggest that there is a strong need to focus on conditions that support self-motivated and self-initiated individual and group learning. For this to occur, a range of cultural and personal dispositions towards learning need to be embedded.

As outlined in the conclusion there are some indications that these dispositions can be established on a small scale within a relatively short period of time, and with explicit focus on cultural formation (as described by Schein, 2010). The challenge will be to find ways to scale – up the factors that have worked in more recent pilot groups and to apply them more broadly at a system level. Despite the apparent failure to deliver a successful prototype, this research has provided a basis from which to start to create a culture within education that enables on-line learning and knowledge-management to occur.

REFERENCES

Abdullah, M., Kimble, C., Benest, I. & Paige, R. (2006). Knowledge based systems: a re-evaluation. *Journal of Knowledge Management*, 10(3), 127-142.

Ackerman, R., Maslin-Ostrowski, P. & Christensen, C. (1996). Case stories: telling tales about school. *Educational Leadership*, 53(6), 21-23.

Alavi M. & Leidner D. (2001). Review: Knowledge Management and Knowledge Management Systems: Conceptual Foundations and Research Issues. *MIS Quarterly*, 25(1), pp107-136.

Ally, M (2004). Using learning theories to design instruction for mobile learning devices. Attewellll, J. and Savill-Smith, C. (eds). *Mobile learning anytime anywhere: A book of papers from MLearn 2004*, p5. Downloaded on 5th January 2013 from http://stu.westga.edu/~bthibau1/MEDT%208484-%20Baylen/mLearn04_papers.pdf#page=14

Amiel, T. & Reeves, T. (2008). Design-based research and educational technology: rethinking technology and the research agenda. *Educational Technology & Society*, 11(4), 29-40.

Anand A. & Singh,M. (2011). Understanding Knowledge Management: A literature Review, *International Journal of Engineering Science and Technology*, 3(2), 926-939.

Anderson, T. & Shattuck, J. (2012). Design-based research: A decade of progress in education research? *Educational Researcher*, 41, 16-25.

Andrews, K.M. & Delahaye, B.L. (2000). Influences on knowledge processes on organisational learning the psychosocial filter. *Journal of Management Studies*, 37(6), 797-810.

Ardichvili, A. (2008). Learning and knowledge sharing in virtual communities of practice: motivators, barriers and enablers. *Advances in Human Resources*, 10(4) 541-554.

Ardichvili, A., Page, V. & Wentling, T. (2003). Motivation and barriers to participation in virtual knowledge sharing teams. *Journal of Knowledge Management*, 7(1), 64-77.

Ardichvili, A. & Yoon, S. (2010). Situated learning theory and activity theory-based approach to designing integrated knowledge and learning management systems. *International Journal of Knowledge Management*, 6(4), 47.

Argote, L., McEvily, B. & Reagans, R. (2003). Managing knowledge in organizations: An integrative framework and review of emerging themes. *Management Science*, 49(4), 571-582.

Agarwal, R. & Prasad, J. (1997). The role of innovation, characteristics and perceived voluntariness in the acceptance of information technologies. *Decision Sciences*, 28(3), 357-388.

Bannan-Ritland, B. (2003). The role of design in research: the integrative learning design framework. *Educational Researcher*, 32(1), 21-24.

Barab, S. & Squire, K. (2004). Introduction: Design-based research: Putting a stake in the ground. *The Journal of the Learning Sciences*, 13(1), 1-14.

Barab, S.A. & Kirshner, D. (Eds). (2001) Special issue: Rethinking methodology in the learning sciences. *Journal of the Learning Sciences*, 10(1&2), 1-222.

Barab, S.A. & Kirshner, D. (Eds). (2001). Rethinking methodology in the learning sciences. [Special Issue] *Journal of the Learning Sciences*, 10(1&2).

Barab, S., MacKinster, J., Moore, J., Cunningham, D. & the ILF Design Team (2001). Designing and building an online community: the struggle to support sociability in the Inquiry Learning Forum. *Educational Technology Research and Development*, 49(4) 71-96.

Barab, S., Barnett, M., Yamagata-Lynch, L., Squire, K. & Keating, T. (2002). Using activity theory to understand the systemic tensions characterizing a technology rich introductory course. *MIND, CULTURE, AND ACTIVITY*, 9(2), 76-107.

Barabasi, A. (2002). *Linked: The New Science of networks*, Cambridge, MA, Perseus Publishing.

Marsky, E. & Purdon, M. (2006). Introducing web-2: social networking and social bookmarking for health librarians. *Journal of the Canadian Health Libraries Association*, 27(3), 65-67.

Bassi, L.J. (1997). Harnessing the power of intellectual capital, *Training and Development*, 51(12), 25-30.

Barnes, C. & Tynan, B. (2007). The adventures of Miranda in the brave new world: learning in a Web 2.0 millennium. *ALT-J*, 15(3), 189-200.

- Beijerse, R.P. (1999). Questions in knowledge management: defining and conceptualising a phenomenon. *Journal of Knowledge Management*, 3(2), pp94-109.
- Bell, F. (2011). Connectivism: Its place in theory-informed research and innovation in technology-enabled learning. *The International Review of Research in Open and Distance Learning*, 12(3).
- Bell, P. (2010). On the theoretical breadth of design-based research in education. *Educational Psychologist*, 39(4), 243-253.
- Bennett, K. & McGee, P. (2005). Transformative power of the learning object debate, *Open Learning*, 20(1), 15-30.
- Bereiter, B. & Scardamalia, M. (1989). Intentional learning as a goal of instruction. In L.B. Resnick (Ed.). *Knowing, learning and instruction: Essays in honor of Robert Glaser (pp361-392)*. Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.
- Bereiter, B. (2002). *Education and mind in the knowledge age*. Mahwah, NJ: Lawrence Erlbaum Associates.
- Bhardwaj, M. & Monin, J. (2006). Tacit to Explicit: an interplay shaping organizational knowledge. *Journal of Knowledge Management*, 10(3), 72-80.
- Bibeau, S. (2001). Social presence, isolation, and connectedness in online teaching and learning: From the literature to real life. *Journal of Instruction Delivery Systems*, 15(3), 35-39.
- Bloor, M., Frankland, J., Thomas M. & Robson, K. (2001). *Focus Groups in Social Research*. London: Sage.

Boitschwarelo, B. (2007). Exploring online communities of practice for biology teachers in Botswana. (Unpublished doctoral thesis). Deakin University, Melbourne.

Boitschwarelo, B. (2009). Constraints to and opportunities for ICT-supported teacher professional development in Africa: The case of biology teachers in Botswana.

http://ou.nl/Docs/Campagnes/ICDE2009/Papers/Final_paper_269Boitshwarelo.pf

Boitschwarelo, B. (2011). Proposing an integrated framework for connectivism: Utilising Theoretical Synergies. *The International Review of Research in Open and Distance Learning*, 12(3).

Boje, D.M. (2001), *Narrative Methods for organisational and communication research*, Sage, London.

Bolloju, N., Khalifa, M.& Turban, E. (2002). Integrating knowledge management into enterprise environments for the next generation decision support. *Decision Support Systems*, 33, 163-176.

Bouch, A., Kuchinsky, A. & Bhatti, N. (2000). Quality is in the eye of the beholder: Meeting users' requirements for internet quality of service. In *Proceedings of CHI 2000*, (pp297–312).

Bransford, J., Sherwood, R., Hasselbring, T., Kinzer, C. & Williams, S. (1990). Anchored instruction: Why we need it and how technology can help. In D. Nix & R. Spiro (Eds). *Cognition education and multimedia: Exploring ideas in high technology* (pp115-141). Hillsdale, NJ: Lawrence Erlbaum.

Brown, A. (1992). Design Experiments: Theoretical and methodological *challenges* in creating complex interventions in classroom settings. *The Journal of the Learning Sciences*, 2(2): 141-178.

Brown, A. & Campione, J. (1990). Communities of learning and thinking, or a context by any other name. *Human Development*, 21, 108-125.

Brown, S., Collins, A. & Dugoid, P. (1989). Situated Cognition and the Culture of Learning. *Educational Researcher*, 18(1), 32-42.

Brown, J., Denning, S., Groh, K. & Prusak, L. (2004). *Storytelling in Organisations: How narrative and storytelling are transforming 21st century management*. Butterworth Heinemann, London.

Brown, J. S. & Duguid, P. (2001). Knowledge and organization: A social-practice perspective. *Organization Science*, 12(2), 198-213.

Brown, A. & Kane, M. (1988). Preschool children can learn to transfer: Learning to learn and learning from example. *Cognitive Psychology*, 20, 493-523.

Brusilovsky, P., [Schwarz, E.](#) & [Weber, G.](#) (1997). Electronic textbooks on WWW: from static hypertext to interactivity and adaptivity. In [Web Based Instruction](#), B.H. Khan (ed.). Educational Technology Publications, Englewood Cliffs, New Jersey, pp255-261.

Carroll, J., Choo, C., Dunlap, D., Isenhour, P., Kerr, S., MacLean, A. & Rosson, M. (2003). Knowledge Management Support for Teachers. *Educational Technology: Research and Development*, (51) No4, pp42-64.

Carroll, J., Chin, G., Rosson, M. & Neale, D. (2000). The development of cooperation; Five years of participatory design in the virtual school. In D. Boyarski and W. Kellogg (eds), *DIS'2000: Designing interactive systems* (Brooklyn, New York, August 17-19' pp239-251. New York: Association for Computing Machinery.

Carroll, J., Rosson, M., Dunlap, D. & Isenhour, P. (2003). Frameworks for sharing knowledge: towards a professional language for teaching practices. *Hawaii International Conference on System Sciences*, HICSS-36, (January 6-9), Kona.

Chandler, P. & Sweller, J. (1991). Cognitive load theory and the format of instruction. *Cognition and Instruction*, 8(4), 293-332.

Chen, S.Y. & Macredie, R.D. (2005). Assessment of the User Interface of Electronic Shopping: a Heuristic Evaluation. *International Journal of Information Management*, 25(6), 516-532.

Child, J. & Shumate, M. (2007). The impact of communal knowledge repositories and people-based knowledge management on perceptions of team effectiveness. *Management Communications Quarterly*, 21(1), 29-54.

Childs, M., Keppell, M., Brown, M., Hunter, C., Hard, N. & Hughes, H. (2011). Fostering institutional change through learning leadership – a study of stories of adaptation in blended and flexible learning and distance education. In G. Williams, P. Statham, N. Brown and B. Cleland (Eds). *Changing Demands, Changing Directions, Proceedings ascilite Hobart 2011*, (pp220-226).

Chiu, C., Hsu, M. & Wang, E. (2006). Understanding knowledge sharing in virtual communities: an integration of social capital and social cognitive theories. *Design Support Systems*, 42, 1872-1888.

Chivhanga. (2001). Impact Assessments of Websites. Downloaded on 4th February 2013. <http://www.soi.city.ac.uk/research/isrg/isrgmembers.htm>

Christenson, C.R., Garvin, D.S. & Sweet, A. (1991). *Education for Judgement: The Artistry of Discussion Leadership*, Harvard Business School, Boston.

Churchland, P. & Sejnowski, T. (1992). *The Computational Brain*. MIT Press, Cambridge, Mass.

Cilliers, P. (2005). Complexity, deconstruction and relativism. *Theory, Culture and Society*, 22(5), 255-267.

Cilliers, P. (2010). The value of complexity. A response to Elizabeth Mowat and Brent Davis. *Complicity: An International Journal of Complexity and Education*, 7(1) 39-42.

Clark, R.E.(1994). Media will never influence learning, *Educational Technology Research and Development*, 42(2), 21-9.

Clark, A. (1997). *Being there: Putting brain, body, and world together again*. Cambridge, MA: MIT Press.

Cobb, P. & diSessa, A. (2004). Ontological innovation and the role of theory in design experiments. *The Journal of the Learning Sciences*, 13(1), 77-103.

Cobb, P., Confrey, J., diSessa, A., Lehrer, R. & Schauble, L. (2003). Design experiments in educational research. *Educational Researcher*, 32(1), 9-13.

Cole, M. (1996). *Cultural Psychology: a once and future discipline*. Cambridge: MA: Belknap Press.

Cole, M. (2001. January 19-20). *Sustaining model systems of educational activity: Designing for the long haul*. Paper presented at the symposium honouring the work of Ann Brown, Berkeley, CA. Retrieved March 2013 from <http://lchc.uesd.edu/People/MCole/ann.html>

Collins, A., Brown, J.S. & Newman, S.E. (1989). Cognitive apprenticeship: Teaching the crafts of reading, writing, and mathematics. In L.B. Resnick (Ed), *Knowing, learning, and instruction: Essays in honor of Robert Glaser* (pp.453-494). Hillsdale, NJ: Lawrence Erlbaum Associates.

Collins, A., Joseph, D. & Bielaczyc, K. (2004). Design research: Theoretical and methodological issues. *Journal of the Learning Sciences*, 13(1; 1), 15-42.

Collins, A & Halverson, R (2010). The second educational revolution: Rethinking education in the age of technology. *Journal of Computer Assisted Learning*, 26(1), 18-27.

Collis B. & Margaryan, A. (2004), Applying activity theory to computer-supported collaborative learning and work-based activities in corporate settings. *Educational Technology Research and Development Journal*, 52(4), 38-52.

Conrad, D. (2008). From community to community of practice: Exploring the connection of online learners to informal learning in the workplace. *American Journal of Distance Education*, 22(1), 3-23.

Contractor, N. & Monge, P. (2002). Managing knowledge networks. *Management Communication Quarterly*, 16(2), 249-259.

Cook, S. & Brown, J. (1999). Bridging epistemologies: The generative dance between organizational knowledge and organizational knowing. *Organisational Science*, 10(4), 381-399.

Crawford, M. (2001), "King John's Christmas: Developing Leadership Communities On-line", *Paper presented at annual meeting of the American Educational Research Association*, Seattle USA, April 2001. 1-18.

Cress, U. & Kimmerle, J. (2007). A theoretical framework for collaborative knowledge building with wikis: A systemic and cognitive perspective. In C. Chinn, G. Erkens & S. Puntambekar. (Eds), *Proceedings of the 7th Computer Supported Collaborative Learning Conference* (pp153-161). New Brunswick: International Society of the Learning Sciences, Inc.

Creswell, J. (2003). *Research Design. Qualitative, Quantitative and Mixed Methods Approaches* (2nd Edn). University of Nebraska, Lincoln: Sage.

Creswell, J.W. & Miller, D.L. (2000). Determining validity in qualitative inquiry. *Theory into Practice*, 39(3), 124-131.

Cross, R. & Baird, L. (2000). Technology is not enough: improving performance by building organizational memory. *Sloan Management Review*, 41(3), 69-78.

Darken, R.P. & Silbert, J.L. (1993). A toolset for Navigation in Virtual Environments. *Proceedings of ACM User Interface Software & Technology*, 157-165.

Davenport, T.H., DeLong, D.W. & Beers, M.C. (1998). Successful knowledge management projects. *Sloan Management Review* 39(2), 43-57.

Davenport, T. & Prusak, L. (1998). *Working Knowledge: How organisations manage what they know*, USA: Harvard Business School Press.

Davenport, T. & Prusak, L.(2000). *Working Knowledge: How Organisations Manage What they Know*, Harvard Business School Press, Boston, MA.

Davenport, T. (2008). Enterprise 2.0: The New, new Knowledge Management? Posted on February 19, 2008 and downloaded from http://blogs.hbr.org/davenport/2008/02/enterprise_20_the_new_new_know_1.html on 5th October 2012.

Davenport, T., De Long, D. & Beers, M. (1998). Successful Knowledge Management Projects. *Sloan management Review*. Winter 1998, 43-57.

Davis, F., Bagozzi, R. & Warshaw, P. (1989). User acceptance of computer technology: a comparison of two theoretical models. *Management Science*, 35(8), 982-1003.

Davis, F. (1993), User acceptance of computer technology: system characteristics, user perceptions. *International Journal Man-Machines Studies*, 38(3), 475-87.

Davis, F., Bagozzi, R. & Warshaw, P. (1989). User acceptance of computer technology: a comparison of two theoretical models. *Management Science*, 35(8), 982-1003.

Delong, D. & Fahey, L. (2000). Diagnosing cultural barriers to knowledge management. *Academy of management executive*, 14(4), 113-127.

Demarest, M. (1997). Understanding Knowledge Management. *Long Range Planning*, 30, 374-384.

Denzin, N.K. (1978). The research act: A theoretical introduction to sociological methods. New York: McGraw-Hill.

DeRue, D.S. & Ashford, S. (2010). Power to people: Where has personal agency gone in leadership development? *Industrial and Organisational Psychology: Perspectives on Science and Practice*, 3, 24-27.

Design-Based Research Collective. (2003). Design-based research: an emerging paradigm for educational inquiry. *Educational Researcher*, 32(1), 5-8.

Desurvire, H. & Wilberg, C. (2009). Game usability heuristics (PLAY) for evaluating and designing better games: the next iteration. OCSC '09 Proceedings of the 3d International Conference on Online Communities and Social Computing: Held as Part of HCI International 2009 (pp557-566). Berlin, Heidelberg: Springer-Verlag.

Dexter, S., Riedel, E & Scharber, C. (2011). ETIPS Leadership Cases: an innovative tool for developing administrative decision making. *Journal of research on Leadership Education*, 6, 250-271.

Dinham, S. (2008). *How to get your school Moving and improving*. ACER Press: Camberwell, Vistoria.

Dixon, N.M. (2000). *Common knowledge: How companies thrive by sharing what they know*. Boston, MA, Harvard Business School Press.

Downes, S. (2006). Learning networks and connective knowledge. Retrieved (2nd February 2013) from <http://it.coe.uga.edu/itforum/paper92.html>

Downes, S. (2012). Knowledge, Learning and Community. Retrieved 2nd February 2013) from <http://www.downes.ca/post/57737>

Drexler, W. (2010). The networked student model for construction of personal learning environments: Balancing teacher control and student autonomy. *Australasian Journal of Educational Technology* 26(3), 369-385.

Ducker, P. (1959). *Landmarks of Tomorrow – A report on the New “Post Modern” world*, Transaction Publishers, New Brunswick, NJ, USA.

Dunaway, M.K. (2011). Connectivism: Learning theory and pedagogical practice for networked information landscapes. *Reference Services Review*, 39(4), 675-685.

Dyer, J.H. & Nobeoka, K. (2000). Creating and managing a high performance knowledge-sharing network, the Toyota case, *Strategic Management Journal*, 21, 345-67.

Engestrom, Y. (1998). Reorganising the motivational sphere of classroom culture: An activity theoretical analysis of planning in a teacher team. In F. Seeger, J. Vioght,

& U. Waschescio (Eds). *The culture of the mathematical classroom*. New York: Cambridge University Press.

Engestrom, Y. (1999). Expansive visibilization of work: An activity-theoretical perspective. *Computer Supported Cooperative Work*, 8, 63-93.

Engestrom, Y. (2001), Expansive Learning at Work, *Journal of Education and Work*, 14(1), 133-156

Engeström, Y., Miettinen, R. & Punamäki, R. (1999). *Perspectives on Activity Theory*. Cambridge University Press.

Engestrom, Y., Engestrom, R. & Karkkainen, M. (1995). Polycontextuality and Boundary Crossing in Expert Cognition: Learning and Problem Solving in Complex Environments, *Learning and Instruction*, 5, 319-336.

Erikson, T. (1995). Notes on design practice: Stories and prototypes as catalysts for communication. In J. Carroll (Ed.), *Envisioning technology: The scenario as a framework for the system development lifecycle* (pp37-58). New York: John Wiley.

Ertmer, P. & Newby, B. (1993). Behaviorism, Cognitivism, Constructivism: Comparing Critical Features from an Instructional Design Perspective. *Performance Improvement Quarterly*, 6(4), 50-72.

Evans, J & King, V. (1999). Business-to-Business planning and the world wide web – planning, managing and assessing web sites. *Industrial Marketing Management*, 28(4), 343-358.

Federoff, M. (2002). Heuristics and Usability Guidelines for the

Creation and Evaluation of Fun in Video Games. Unpublished master's thesis, Indiana University, Bloomington, Indiana.

Fish, S. (1980). *Is there a text in this class? The authority of interpretive communities*. Cambridge, MA: Harvard University Press.

Fine, G. (1983). *Shared fantasy: Roleplaying games as social worlds*. Chicago: University of Chicago Press.

Floyd, C. (1997). Outline of a paradigm change in software engineering. In G. Bjerknes, P Ehn and M. Kyng (Eds.), *Computers and democracy: A Scandinavian challenge*. Brookfield VT: Gower.

Fontana, A. & Frey, J. (2000). The interview: From structured questions to negotiated text. In N. Denzin and Y. Lincoln (Eds.), *Handbook of Qualitative Research* (2nd edn, pp645-72). Thousand Oaks, CA: Sage

Frankland, J. & Bloor, M. (1999). Some issues arising in the systematic analysis of focus group material, In R. Barbour and J. Kitzinger (eds) *Developing Focus Group Research: Politics, Theory & Practice*, London: Sage.

Friesen, N. (2004). Three Objections to Learning Objects and E-learning standards, *Online Education Using Learning Objects*, In R. McGreal (Ed), London: Routledge, 59-70.

Gagne, R.M. (1985). *The Conditions of Learning* (4th Ed). New York: Holt, Rinehart and Winston.

Gallivan, M. J. (2001). "Organizational Adoption and Assimilation of Complex Technological Innovations: Development and Application of a New Framework," Database for Advances in Information Systems, Summer 2001, vol.35, issue 3, pp51-85

Garavan, T. (1997). The learning organization; A review and evaluation. *The Learning Organization*, 4(1), 18-29.

Garcia, B. (2006). "Learning Conversations: knowledge, meanings and learning networks in Greater Manchester", *Journal of Knowledge Management*, 10(5), 99-109.

Garfile, S. (2006). Ten reasons why people don't share their knowledge. *KM Review*, 9(2),10-11.

Glotzbach, R., Mohler, J. & Radwan, J (2007). RSS as a course information delivery method. ACM SIGGRAPH 2007 educators program, 09/2007. Downloaded on 12th July 2012 from:

http://delivery.acm.org.ezproxy.uow.edu.au/10.1145/1290000/1282057/a16-glotzbach.pdf?ip=130.130.37.84&id=1282057&acc=ACTIVE%20SERVICE&key=C2716FEBFA981EF15E4BFB9DBBCB5F1B109B1AC210BBC559&CFID=243555334&CFTOKEN=75880575&_acm_=1378598857_6f2825dc97f658364fd5165e4c4581ec

Goeke, J. (2008). A preliminary investigation of prospective teachers' reasoning about case studies with expert commentary. *Teacher Education and Special education: The Journal of the Teacher Education Division of the Council*, 31, 21-35.

Goffe, R. & Jones, G. (2003). *The character of a corporation: How your company's culture can make or break your business*. Profile Business Publications.

Goldsmith, R.E. & Pillai, K.G. (2006). Knowledge Calibration. In D. Schwartz (Ed.), *Encyclopedia of Knowledge* (pp311-316): Idea House.

Grandon, E., Alshare, O. & Kwan, O. (2005). Factors influencing student intention to adopt online classes: A cross-cultural study. *Journal of Computing Sciences in Colleges*, 20(4), 46–56.

Gravemeijer, K. (1994). Educational Development and development research in mathematics education. *Journal for Research in Mathematics Education*, 25(5), 443-471.

Gravenotter, M. (1983). The strength of weak ties: A network theory revisited. *Sociological Theory*, 1, 201–233.

Gredler, M.E. (2005). *Learning and instruction: Theory into practice* (5th edn.). Upper Saddle River, NJ: Pearson.

Gross, G. (2005). Standards a must for adoption for health-care IT. *CIO Magazine*, March 15.

Guba, E.G. & Lincoln, Y.S. (1981). Effective evaluation: Improving the usefulness of evaluation results through responsive and naturalistic approaches. San Francisco, CA: Jossey-Bass.

Guba, E.G. & Lincoln, Y.S. (1982). Epistemological and methodological bases of

naturalistic inquiry. *Educational Communication and Technology Journal* 30(4), 233-252.

Guba, E.G. & Lincoln, Y.S. (1989). *Fourth generation evaluation*. Newbury Park, CA: Sage.

Hall, M. (2006). "Knowledge Management and the Limits of Knowledge Codification", *Journal of Knowledge Management*, 10(3), 117-126.

Hansen, M.T., Nohria, N. & Tierney, T. (1999). What's your strategy for managing knowledge? *Harvard Business Review*, 77(2), 106-116.

Hargreaves, A. (1994). *Changing teachers, changing times: Teachers work and culture in the postmodern age*. (London, Cassell).

Hargraves, A. (2003). *Teaching in the Knowledge Society: Education in the age of insecurity*. New York: Teachers College Press.

Hargraves, D. (1988). *Creative Professionalism: The Role of Teachers in a Knowledge Society*. London, UK:DEMOS.

Hartley, K. (1999). Media overload in instructional web pages and the impact on learning. *Educational Media International*, 36(2):145-150.

Hasan, H, Vererikina, I. & Gould, E. (2003). (Eds.) *Information Systems and Activity Theory: Volume 3, Expanding the Horizon*, University of Wollongong Press.

Hatton, N. & Smith, D. (1995). Reflection in teacher re-education: Toward definition and implementation. *Teaching and Teacher Education*, 11: 33-49.

Hennink, M. (2007). *International focus group research: a handbook for the health and social sciences*. Cambridge University Press.

Herrington, J. & Oliver, R. (2000). An instructional framework for authentic learning environments. *Educational Technology Research and Development*, 48(3), 23-48.

Hewitt, J. (2003). How habitual online practices affect the development of asynchronous discussion threads, *Journal of Educational Computing Research*, 28 (1), 31-45.

Hewitt, J. (2004). An exploration of community in a knowledge forum classroom: an activity system analysis. In S.A. Barab, R. King and J. Gray (Eds). *Designing for virtual communities in the service of learning* (pp210-238). Cambridge: Cambridge University Press.

Hildreth, P. & Kimble, C. (2002). The duality of knowledge. *Information Research*, 8(1).

Ho, C., Au, W. & Leung, J. (2004). A three-factor model on teacher professionalism. *Educational Research Journal*, 19(2), 223-249.

Hoffman, DL. & Novak, T.P. (1996). "Marketing in Hypermedia Computer-Mediated Environments: Conceptual Foundations," *Journal of Marketing*, 60 (July), 50-68.

Huberman, M. (1993). The model of the independent artisan in teachers' professional relations. In J.W. Little and M.W. McLaughlin (Eds). *Teachers Work: Individuals, Colleagues and Contexts*. NY and London, Teachers College Press.

Hung, W., Smith, T., Harris, M. & Lockard, J. (2007) Development research of a teachers' educational performance support system: the practices of design, development and evaluation. *Education Technology Research Development*, 58:61-80.

Huysman, M. (2005). The role of information Technology in Building and Sustaining the Relational Base of Communities, *The Information Society*, 21, 81-89.

Hyden, L.C. & Bulow, P.H. (2003). "Who's Talking: Drawing Conclusions from Focus Groups – Some Methodological Considerations", *International Journal of Social Research Methodology*, vol.6, no.4, pp305-321.

Hyeonjin, K. & Hannafin, M. (2008). Situated case-based knowledge: An emerging framework for prospective teacher learning. *Teaching and Teacher Education*, 24(7), 1837-1845.

Igbaria, M. & Tan, M. (1997). The consequences of information technology acceptance on subsequent individual performance. *Information and Management*, 32(3), 113-121.

Ingersoll, R.M. & Merrill, E. (2011). The Status of Teaching as a Profession. In J. Ballantine and J. Spade (Eds), *Schools and Society: A Sociological Approach to Education*, (pp185-189) 4th Edn. CA: Pine Forge Press/Sage Publications.

Intrac NGO Policy Briefing Paper No. 5, November 2001 For the INTRAC-NGO Research Programme. Downloaded on 5th February 2013:

<http://www.intrac.org/data/files/resources/41/Briefing-Paper-5-Evaluating-Websites.pdf>

Issroff, K. & Scanlon, E. (2002). Using technology in higher education: An activity theory perspective. *Journal of Computer Assisted Learning*, 18(1), 77-83.

Jacobsen, C. (2009). The carrot or the stick? A study on motivation, behaviour and performance of public employees. Retrieved from:

www.akf/psm_en/papers/c_jacobsen_projdesc_01.pdf/

Janicki, T. & Liegle, J.O. (2001). Development and evaluation of a framework for creating web-based learning modules: A pedagogical and systems approach. *Journal of Asynchronous Learning Networks*, 5(1). Retrieved January 10th 2013, from: http://www.sloan-c.org/publications/jaln/v5n1/pdf/v5n1_janicki.pdf

Jasimuddin, S. (2008). A holistic view of knowledge management strategy. *Journal of Knowledge Management*, 12(2), 57-66.

Jennex, M. & Olfman, L. (2005). Assessing knowledge management success/effectiveness models. *International Journal of Knowledge Management*, 1(2), 33-49.

Joanssen, D. & Rohrer-Murphy, L. (1999). Activity theory as a framework for designing constructivist learning environments. *Educational Technology Research and Development*, 47(1), 61-79.

Johnson, A. (1996). It's good to talk: the focus group and the sociological imagination. *Sociological Review*, 44(3), 517-538.

Jonassen, D. (2000). Revisiting activity theory as a framework for designing student-centred learning environments. In D.J. Jonassen and S.M. Lands (Eds), *Theoretical*

foundations for learning environments, pp89-122, Mahwah: Lawrence Erlbaum Associates.

Jonassen,D., Carr,C. & Yueh, H. (1998). Computers as mindtools for engaging learners in critical thinking. *TechTrends*, 43 (2), 24-32.

Jones, C. Ferreday, D & Hodgeson, V. (2008). Networked Learning a relational approach: weak and strong ties. *Journal of Computer Assisted Learning*, 24(2), 90-102.

Jones, T.S. & Richey, R.C. (2000). Rapid prototyping methodology in action: A developmental study. *Educational Technology, Research and Development*, 48(2), 63-80.

Joseph, D. (2004). The practice of design-based research: Uncovering the interplay between design, research, and the real world context. *Educational Psychologist*. 39(4), 235-242.

Kaplan, R.S. & Norton, D.P. (1996). Using the Balanced Scorecard as a strategic management system. *Harvard Business Review*, Jan-Feb pp75-85.

Kaptelinin, V. (1996). Computer-mediated activity: functional organs in social and developmental contexts. In B.A. Nardi (Ed.), *Context and consciousness: Activity theory and human-computer interaction*, Cambridge, MIT.

Kato, H., Hatano, K., Sakamoto, T., Morimoto, H., Komika, T. & Matsuda,F. (2003). "Development of Web-based Resource Management System for Educational Knowledge Circulation". *World Conference on E-learning in Corporate, Government, HealthCare, and Higher Education (ELEARN) 2003*:1.

- Katz, S. & Earl, L. (2010). Learning about Networked Learning Communities. *School Effectiveness and School Improvement*, 21(4), 27-51.
- Kelly, A.E. (2003). Research as design. *Educational Researcher*, 32(1), 3-4.
- Kelly, A. (2004). Design Research in education: yes, but is it methodological? *The Journal of the Learning Sciences*, 13(1), 115-128.
- Kerr, B. (2007). A challenge to connectivism. Transcript of keynote speech. Online Connectivism Conference, University of Manitoba. Downloaded 6th January 2013 from: <http://learningevolves.wikispaces.com/kerr>
- Kim, H. & Hannafin, M. (2008). Grounded design of web-enhanced case-based activity. *Education Technology Research Development*, 56, 161-179.
- Kimble, C. & Bourdon, I. (2008). Some success factors for the communal management of knowledge. *International Journal of Information Management*, 28, 461-467.
- Kirschner, P.A., Martens, R.L. & Strijbos, J.W. (2004). CSCL in Higher Education, in J.W. Strijbos, P.A. Kirschner and R.L. Martens (Eds). *What we Know about CSCL and Implementing it in Higher Education: Computer Supported Collaborative Learning Series vol.3*, Kluwer Academic Publishers, London, 31-50.
- Keyes, E. (1993). Typography, color and information structure. *Technical Communication*, 1993:638-654.
- Kidd, A., "The Marks are on the Knowledge Worker", *Conference on Human Factors in Computing Systems: CHI '94, Proceedings of the SIGI conference on*

Human Factors in computing systems: Celebrating interdependence, Boston Mass. (14-18 April 1994), ACM Press: New York, 186-191.

Kitzinger, J. (1994). The methodology of Focus Groups: the importance of interaction between research participants. *Sociology of Health & Illness*, 16: 103-121.

Knowlton, D.S, (2001). "Promoting durable knowledge construction through on-line discussion", *Paper presented at the Proceedings of the Annual Mid-South Instructional Technology Conference*, Murfreesboro, April 2001.

Kop, R. & Hill, A. (2008). Connectivism: Learning theory of the future or vestige of the past? *The International Review of Research in Open and Distance Learning*, 9(3).

Koppi, T., Bogle, L. & Bogle M. (2005). Learning Objects, repositories, sharing and reusability. *Open Learning*, 20(1), 83-91.

Korper, S. & Ellis, J. (2000). *The e-commerce Book: Building the E-Empire*. London: Academic Press.

Kozma, R.B. (1994). Will media influence learning? Reframing the debate. *Educational Technology: Research and Development*, 42(2):7-19.

Kruger, R. (1994). *Focus Groups: a practical guide for applied research*. Sage Publications.

Lai, H. & Chu, T. (2000). Knowledge Management: A review of theoretical frameworks and industrial cases. *Paper presented at the 33rd Hawaii International Conference on System Sciences*, Maui, Hawaii.

Lave, J. (1988). *Cognition in practice: Mind, mathematics and culture in everyday life*. New York: Cambridge University Press.

Lave, J & Wenger, E.(1991). *Situated Learning: Legitimate Peripheral Participation*, Cambridge University Press, New York, NY.

LanSia, C. & Al-Hawamdeh, S. (2003). Taxonomy-building tools: an investigative study. *Journal of Information and Knowledge Management*, 2(2), 63-77.

Law, R., Qi, S. & Buhalis, D. (2010). [A review of website evaluation in tourism research](#) *Tourism Management*, vol.31 (3), pp297-313.

Leask, J., Hawe, P. & Chapman, S. (2001). Focus group composition: A comparison between natural and constructed groups. *Australian and New Zealand Journal of Public Health*, 25(2), 152-154.

Lee, M.K.O., Cheung, C.M.K. & Chen, Z. (2005). Acceptance of Internet-based learning medium: The role of extrinsic and intrinsic motivation. *Information & Management*, 42, 1095-1104.

Lefoe, G., O'Reilly, M., Bennett, D., Keppell, M. & Gunn, C. (2007). The Carrick exchange: not just another repository. In C. Montgomerie and J. Seale. (Eds). *Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications 2007* (pp:108-113). Chesapeake, VA: AACE. Retrieved January 6, 2014 from <http://www.editlib.org/p/25365>

Leeman, Y. & Wardekker, W. (2011). Redesigning vocational education: the possibilities of design based research. *Journal of Curriculum Studies*. 43 (3), 313-331.

Leont'ey, A.N. (1981) *Problems of the development of the mind*, Progress, Moscow.

Liamputtong, P. (2011). *Focus group Methodology: Principles and Practice*. Sage Publications; London.

Liaw, S. & Huang, H. (2000). Enhancing interactivity in web-based instruction: A review of the literature, *Educational Technology*, 40(3), 41-45.

Lieberman, A & Mace, D. (2009). The role of “accomplished teachers” in professional learning communities: Uncovering practice and enabling leadership, 15(4), 459-470.

Lippenon, L., Hakkarainen, K. & Paavola, S. (2004). “Practices and Orientations of CSCL”, in J. Stribos, P. Kirshner and R. Martens. (Eds). *What we Know about CSCL and Implementing it in Higher Education: Computer Supported Collaborative Learning Series vol.3*, Kluwer Academic Publishers, London, 31-50.

Little, J.W. (1990). The persistence of privacy: autonomy and initiative in teachers’ professional relations, *Teachers College Record*, 91(4), 509-536.

Liu, S., Liao, H. & Peng, C. (2005). Applying the technology acceptance model and flow theory to online e-learning users’ acceptance behaviour. *Issues in Information Systems*, 6(2), 175-181.

Lordly, D. (2007). Once Upon a Time ... Storytelling to Enhance Teaching and Learning. *Canadian Journal of Dietetic Practice and Research*, vol.68 no.1, 30-36.

Lu, M.T. & Yeung, W.L. (1998). “A Framework for Effective Commercial Web

Application Development”, *Internet Research: Electronic Networking Applications and Policy*, vol.8, no.2, pp166-173.

Lytras, M. & Pouloudi , N. (2001). “Expanding e-learning effectiveness. The shift from content orientation to knowledge management utilization”. *World Conference on Educational Multimedia, Hypermedia and Telecommunication*, (ED-MEDIA 2001), Jun 25-30, 2001, Tampere, Finland (CD Proceedings).

Lytras, M. & Pouloudi, N. (2002a). “Knowledge Management Convergence: Expanding Learning Frontiers”. *Journal of Knowledge Management*, 6, 40-51.

Lytras, M., Pouloudi, N. & Poulymenakou, A. (2002). “Dynamic E-Learning Settings through Advanced Semiotics: The Value Justification of a Knowledge Management Oriented Metadata Schema”. *International Journal on E-Learning*, October-December 2002, 49-61.

McAdam,R. & McGreedy, S. (1999). A Critical review of knowledge management models, *The Learning Organization*, 6(3), 91-100.

McAdam, R. & Reid, R. (2001). SME and large organizational perceptions of knowledge management: comparisons and contrasts. *Journal of Knowledge Management*, 5(3), 231-41.

McAfee, A. (2006). Enterprise 2.0: The Dawn of Emergent Collaboration *Management of Technology and Innovation*, 47(3).

McCall, M. (2010). Peeling the onion: Getting inside experience-based leadership development. *Industrial and Organisational Psychology*, 3: 61-68.

McCall, M, Lombardo, M. & Morrison, A. (1988). *The lessons of experience: How successful executives develop on the job*. Lexington, MA: Lexington Books.

McLaughlin, M. (1993). What matters most in teachers' workplace context? In J.W. Little and M.W. McLaughlin. (Eds). *Teachers Work: Individuals, Colleagues and Contexts*. NY and London, Teachers College Press.

McLaughlin, M. & Talbert, J. (2001). Professional communities and the work of high school teaching. Chicago: University of Chicago Press.

McLaughlin, M. & Talbert, J. (2006). Building school-based teacher learning communities: Professional strategies to improve student achievement. New York: Teachers College Press.

McLure-Wasko, M. & Faraj, S. (2005). Why should I share? Social capital and knowledge contribution in electronic networks of practice. *MIS Quarterly* 29(1), 35-57.

Ma, Y. & Harmon, S. (2009). A case study of design-based research for creating a vision prototype of a technology based innovative learning environment. *Journal of Interactive Learning Research*, 20(1), 75-93.

Mackey, J. & Evans, T. (2011). Interconnecting networks of practice for professional learning. *International Review of Research in Open and Distance Learning*, 12(3) 1-15.

Magoulas, G.D., Chen, S.Y & Papanikolaou, K.A.(2003). Integrating Layered and Heuristic Evaluation for Adaptive Learning Environments. Second Workshop on

Empirical Evaluation of Adaptive Systems in conjunction with the User Modelling
2003 Conference (UM2003), 5-14 June, 2003, University of Pittsburgh.

Maier, R. & Remus, U. (2003). "Implementing process-oriented knowledge
management strategies", *Journal of Knowledge Management*, vol.7 (4).

Maor, D. & Volet, S. (2007). Engagement in professional on-line learning: A
situative analysis of media professionals who did not make it. *International Journal
of e-learning*, 6(1), 95-117

Marcus, N., Cooper, M. & Sweller, J. (1996). Understanding Instructions. *Journal of
Educational Psychology*, 88(1): 49-63.

Marden, M. (2008). The travel project: designing and implementing an online
community of learners using design based research. Paper presented at proceedings
of the Emerging Technologies Conference, University of Wollongong, 18-21 June,
2008.

Marx, K. (1992). *Capital: A Critique of Political Economy*, vol. 1, Penguin Books,
London.

Mathison, S. (1988). Why Triangulate? *Educational Researcher*. 17(2), 13-17.

Mayer, R.E. (1993). Illustrations that instruct. In R. Glasser (ed.), *Advances in
Instructional Psychology* (pp253-282). Hillside. NJ: Erlbaum.

Means, T. & Wang, F. (2003). " KITE: A Knowledge Management Approach for
Sharing Technology Integration Experiences in Education Communities". *World*

Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education (ELEARN) 2003:1.

Mellow, G., Woolis, D. & Laurillard, D. (2011). In search of a new developmental-education pedagogy. *Change: The Magazine of Higher Learning*, 43:3, 50-59.

Metaxiotis, K. & Psarras, J. (2003). Applying knowledge management in higher education: the creation of a learning organization. *Journal of Information and Knowledge Management*, 2(4), 1-7.

Miller, G.A. (1956). The magical number seven, plus or minus two: Some limits on our capacity for processing information. *Psychological Review*, 63, 81-97.

Ming-Fong,J.,Yam San, C., & Ek Ming,T.. (2005). Unpacking the Design Process in design-based research. *International Conference on the Learning Sciences:2:470-471.*

Downloaded from

http://cheeyamsan.info/Publications/2010/JanCheeTan_ICLS2010.pdf on the 30th

March 2010

Miniard, P.W. & Cohen, J.B. (1979). Isolating attitudinal and normative influences in behavioural intention models. *Journal of Marketing Research*, 16, 102-110.

Moore, G.C. & Benbasat, I. (1991). ‘Development of an instrument to measure the perceptions of adopting an information technology innovation’. *Information Systems Research* vol.2, no.3 (1991) pp173-191.

Morgan, D.L. (2002). Focus group interviewing. In J.F. Gubrium and J.A. Holstein (Eds). *Handbook of interviewing research: Context & method* (pp141–159).

Thousand Oaks, CA: Sage.

Moreno, R. & Mayer, R. (1999). Cognitive principles of multimedia learning: the role of modality and contiguity. *Journal of Educational Psychology*, 91(2), 358-368.

Mousavi, S., Low, R. & Sweller, J. (1995). Reducing cognitive load by mixing auditory and visual presentation modes. *Journal of Educational Psychology*, 87(2), 319-334.

Muller, J., Matheson, L., Page, C. & Gallup, R. (1998). Methods and tools: participatory heuristic evaluation. *interactions*, 5(5) 13-18.

Nardi, B. (1996). Activity theory and human computer interaction. In B.A. Nardi (Ed). *Context and consciousness: Activity theory and human-computer interaction* (pp7-16), Cambridge, MA: MIT Press.

Nicol, D., Littlejohn, A. & Grierson, H. (2005). The importance of structuring information and resources within shared workspaces during collaborative design learning. *Open Learning*, 20(1), 31-49.

Nielsen, J. Heuristic evaluation (1992). In J. Nielsen and R.L. Mack. (Eds). *Usability Inspection Methods*, John Wiley & Sons, New York, NY, 1994, 25-64.

Nonaka, I. (1994). A dynamic theory of organizational knowledge creation. *Organizational Sciences*, 5, 14-37.

Nonaka, I. & Takeuchi, K. (1995), *The knowledge creating company: How Japanese companies create the dynamics of innovation*. Oxford: Oxford University Press.

Nonaka, I. & Konno, N. (1998). The concept of “ba”: Building a foundation for knowledge creation”, *California Management Review*, 40(3), 40-55.

Nortan, N. & Keplan, D. (1996). *The balanced scorecard: translating strategy into action*. Boston: Harvard Business School Press.

O'Connell, J. (2008). What's that sound? 'Tweet': New perspectives on leadership and learning. *Access* 23-25.

Oh, E. & Reeves, T. (2012). The implications of the differences between design research and instructional systems design for educational technology researchers and practitioners. *Educational Media International*, 47(4), 263-275.

Orrill, C.H., Hannafin, M.J. & Glazer, E.M. (2002). Disciplined Inquiry and the Study of Emerging Technology. In D. Jonassen. (Ed.). *Handbook of Research on Educational Communications and Technology* [second edition] (pp335-353).

Pace-Marshall, S. (2006). *The power to transform: Leadership that brings learning and schooling to life*. Jossey-Bass.

Paloff, R. & Pratt, K. (Eds). (2007). *Building online learning communities: effective strategies for the virtual classroom*. San Francisco, CA: Jossey-Bass.

Papert, S. & Harel, I. (1991). *Constructionism.: research reports and essays, 1985-1990*. Ablex Publishing Corporation

Park, N. (2009). User acceptance of e-learning in higher education: An application of technology acceptance model. Paper presented at the annual meeting of the International Communication Association, New York.

- Parker, A. & Tritter, J. (2006) 'Focus Group Method and Methodology: Current Practice and Recent Debate, *International Journal of Research on Method in Education*, 29(1) pp.23-37.
- Parrish, P. (2004). "The trouble with learning objects", *Education Technology, Research and Development*, 52(1), 49-67.
- Parr, J. & Ward, L. (2006), Building on Foundations: Creating an Online Community *Journal of Technology and Teacher Education*, 14(4), 775-793.
- Patton, M.Q. (1990). *Qualitative evaluation and research methods* (2nd Ed.). Newbury Park, CA: Sage.
- Pearce, R. (2002). Case-based structured conflict: a means for enhancing classroom learning. *Journal of Management Education*, 26. 732-744.
- Pituch, K. & Lee, L. (2006). The influence of system characteristics on e-learning use. *Computer Education*, 47, 222-244.
- Plus, M. (2009.) Through the maze: social bookmarking for a real network. *Professional Educator*, 7(1), 14-16.
- Polanyi, M. (1966), *The Tacit Dimension*, London: Routledge and Kegan, Paul.
- Polanyi, M. (1983). *The Tacit Dimension*, Peter Smith, New York. NY.
- Polman, J. (2000). *Designing project-based science: connecting learners through guided inquiry*. New York: Teachers College Press.
- Popper, K. (1972). *Objective Knowledge an Evolutionary Approach*, Oxford, UK: Oxford University Press.

- Prensky, M. (2009). "H. Sapiens Digital: From Digital Immigrants and Digital Natives to Digital Wisdom". *Innovate (North Miami Beach, Fla.)* (1552-3233), 5(3).
- Prusak, L., Brown, J., Grob, K., & Denning, S. (2005). *Storytelling in Organisations*. Butterworth-Heinemann.
- Plus, M. (2008). Twitter Viral professional development and networking. *Teacher*. November 2008, 58-60.
- Quinn, J. (1992). *Intelligent enterprise: A knowledge and service based Paradigm for Industry*. The Free Press, New York.
- Ravenscroft, A. (2011). Dialogue and connectivism: A new approach to understanding and promoting dialogue rich networked learning. *The International Review of Research in Open and Distance Learning*. 12(3), 139
- Reamy, T. (2002), Imparting Knowledge Through Storytelling, *KM World*, 11(6), 8-11.
- Reeves, T.C. (2006). Design research from a technology perspective. In J. van den Akker, K. Gravemeijer, S. McKenny and N. Nieveen (Eds). *Educational design Research* (pp52-66). London: Routledge.
- Reeves, T., Herrington, J. & Oliver, R. (2006). Design Research: A Socially Responsible Approach to Instructional Technology Research in Higher Education, *Journal of Computing in Higher Education*, Spring, 16(2), 97-116.

Rehak, D.R. & Mason, R. (2003). Engaging with the Learning Object Economy, in Littlejohn, A., *Re-using Online Resources: A Sustainable Approach to E-Learning*, London: Kogan Page, pp. 22-30

Reissner, S. (2002). Narrative, Organisational Change, Development and Learning. *Paper Presented at the Annual European Society for Research on the Education of Adults. Life History and Biographical Research Network Conference*, Geneva Switzerland, March 7-10, 2002.

Reeves, T. (2000). Enhancing the worth of instructional technology research through “design experiments” and other development research strategies. Paper presented at *International Perspectives on Instructional Technology Research for the 21st Century*, April 27, New Orleans, LA, USA.

Reeves, T.C., Benson, L., Elliott, D., Grant, M., Holschuh, D., Kim, B., Kim, H.

Lauber, E. & Loh, C.S. (2002). Usability and Instructional Design Heuristics for E-Learning Evaluation. In P. Barker and S. Rebelsky, (Eds), in 'Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications 2002 (pp1615-1621). AACE, Chesapeake,

VA <http://www.csloh.com/research/pdf/EdMedia2002.pdf>, <http://treeves.coe.uga.edu/edit8350/HEIPEP.html>

Reeves, T., Herrington, J. & Oliver, R. (2005). Design Research: A socially responsible approach to instructional technology research in higher education. *Journal of Computing in Higher Education*, 16(2), 96-115.

Reeves, T.C. (2006). Design research from a technology perspective. In J.V.D. Akker, K. Gravemeijer, S. McKenney and N. Nieveen. (Eds). Educational design research (pp52-66). UK: Routledge.

Reigeluth, C.M. & Frick, T.W. (1999). Formative research: A methodology for creating and improving design theories. In C.M. Reigeluth (Ed.), Instructional-Design Theories and Models – A New Paradigm of Instructional Theory (pp633-652). New Jersey: Lawrence Erlbaum.

Reissner, S. (2002). Narrative, Organisational Change, Development and Learning. Paper presented at the annual European Society for Research on the Education of Adults. Life History and Biographical Research network Conference, Geneva Switzerland, March 7-10, 2002.

Reushle, S & Antonio, A. (2013). Looking back to look forward: Creating and sustaining peer connections through digital communities. In H. Carter, M. Gosper and J. Hedberg (Eds), *Electric Dreams. Proceedings ascilite 2013, Sydney*. (pp751-755).

Richardson, W. (2008). Blogs, Wikis. Podcasts, and other powerful web tools for classrooms (2nd edn). Corwin Press.

Robinson, V. (1995). Organisational learning as organisational problem solving. *Learning and Managing*, 1(1), 63-78.

Rosenberg, M.J. (2006). Beyond E-Learning, Pfeiffer.com

Rouser, S. (2009). Behind closed doors: a case study of the impact of peer visits to combat isolation and develop reflective practice in high school teachers, Capella University, Pro-Quest, UMI Dissertations Publishing, 3344523.

Rowley, E. (2012). Protocol for a qualitative study exploring the role of “diffusion fellows” in bridging the research to practice gap in the Nottinghamshire, Derbyshire and Lincolnshire collaboration for leadership in applied health research and care (CLAHRC-NDL). *BMJ Open*, 2(1). Downloaded 4th January 2013 from: <http://bmjopen.bmj.com/content/2/1/e000604.full>

Ruggles, R. (1998). The state of the notion: Knowledge management in practice. *California Management Review*, 40(3), 80-89.

Ryan, R.M. & Deci, E.L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist*, 55, 68-78.

Ryan R.M. & Deci E.L. (2000). Intrinsic and extrinsic motivations: classic definitions and new directions. *Contemporary Educational Psychology*, 25, 54-67.

Saade, R., Nebebe, F. & Tan, W. (2007). Viability of the technology acceptance model in multi-media learning environments: Comparative study, *Interdisciplinary Journal of Knowledge and Learning Objects*, 37, 175-184.

Saint-Onge, H. and Armstrong, C. (2004). *The Conductive Organization*. Oxford: Elsevier.

Sallis, E & Jones, G. (2002). *Knowledge Management in Education: Enhancing Learning and Education*, Kogan Page, London.

- Sandoval, V. (2000). Website Evaluation Methodology. Unpublished Paper. In NGO Policy Briefing Paper No 5, November 2001. Downloaded from <http://www.intrac.org/data/files/resources/41/Briefing-Paper-5-Evaluating-Websites.pdf> on 13th September 2012
- Santo, S. (2005). "Knowledge Management: An imperative for Schools of Education", *TechTrends*, 49(6), 42-50.
- Scarbrough, H. (2003). Knowledge management, HRM and the innovation process. *International Journal of Manpower*, 24(5), 501.
- Scardamalia, M. & Bereiter, C. (1983). Child as co-investigator: Helping children gain insight into their own mental processes. In S. Paris, G. Olson, and H. Stevenson (Eds), *Learning and motivation in the classroom* (pp83-107). Hillsdale, NJ: Lawrence Erlbaum Associates.
- Schein, E. (2010). *Organizational Culture and Leadership*. Wiley.
- Schlager, M., Farooq, U., Fusco, J., Schank, P. & Dyer, N. (2009). Analyzing on-line teacher networks: Cyber networks require cyber research tools. *Journal of Teacher Education* 60(1), 86-100.
- Schonstrom, M. (2005). "Creating Knowledge Networks: lessons from practice", *Journal of Knowledge Management*, 9(6), 17-29.
- Schulman, L. (1986). Those who understand: knowledge and growth in teaching. *Educational Researcher*, 15(2), 4-14.

- Schulman, L.S. (1996). Just in Case: Reflections on learning from experience (1996). The Wisdom of Practice: *Essays on teaching, Learning and Learning to Teach* (pp461-482). Jossey-Bass: San Francisco.
- Schum, S. (1997). Negotiating the Construction and Reconstruction of Organisational Memories, *Journal of Universal Computer Science*, 3(8), 899-928.
- Schroff, R., Deneed, C. & Ng, E. (2011). Analysis of the technology acceptance model in examining students' behavioural intention to use an e-portfolio system. *Australian Journal of Educational Technology*, 27(4), 600-618.
- Schwarz, C. (1998). *Developing students' understanding of scientific modelling*. Unpublished doctoral dissertation. University of California, Berkeley.
- Schrader, P., Leu, D., Kinzer, R., Teale, W., Labbo, L. & Cammack, D., (2003). Using internet delivered video cases to support pre-service teachers' understanding of effective literacy instruction: an exploratory study. *Instructional Science*, 31: 317-340.
- Senge, P. (1990). *The Fifth Discipline*. New York, NY, Doubleday.
- Selim, H.M. (2003). An empirical investigation of student acceptance of course websites. *Computers & Education*, 40(4), 343-360.
- Shavelson, R., Phillips, D., Towne, L. & Feur, M. (2003). On the science of education design studies. *Educational Researcher*, 32(1), 25-28.
- Sherif, K. (2006). An adaptive strategy for managing knowledge in organisations. *Journal of Knowledge Management*, 10(4), 72-80.

Shulman, L. (1996). *The wisdom of practice: Essays on Teaching, learning and learning to teach*. San Francisco: Jossey-Bass.

Siemens, G. (2004). *Connectivism: A learning theory for the digital age*.

International Journal of Instructional Technology and Distance Learning. Retrieved on 9th January 2013 from: <http://www.elearnspace.org/Articles/connectivism.htm>

[Siemens, G \(2005, August 10\). Connectivism: Learning as network creation. E-learning space.org website. http://www. Elearnspace.org/articles/networks.htm](http://www.elearnspace.org/Articles/connectivism.htm)

Siemens, G. (2006) *Knowing Knowledge. Knowingknowledge.com electronic book. www.knowingknowledge.com*

Siemens, G. (2006b). *Connectivism: learning theory or pastime of the self-amused*.

Downloaded on the 3rd February 2013 from:

http://www.elearnspace.org/Articles/connectivism_self-amused.htm

[Siemens, G. \(2008\) Learning and Knowing in Networks: Changing roles for educators and designers. Presented to ITFORUM for discussion, January 27, 2008.](http://www.elearnspace.org/Articles/connectivism_self-amused.htm)

[Siemens, G. & Conole, G. \(2011\). Connectivism: Design and Delivery of Social Networked Learning. Editorial. *The International Review of Research in Open and Distance Learning*. 12\(3\)](http://www.elearnspace.org/Articles/connectivism_self-amused.htm)

Simon, H.A. (1974). How big is a chunk? *Science*, 183, 482-488.

Smaling, A. (1990). Enige aspecten van kwalitatief onderzoek en het klinisch interview (Some aspects of qualitative research and the clinical interview).

Tijdschrift voor Nascholing en Onderzoek van her Reken-wiskundeonderwijs, 8(3), 4-10

Smithson, J. (2000). Using and analyzing focus groups: Limitations and possibilities. *International Journal of Social Research Methodology*, 3(2), 103-119.

Snowden, D. (2002), Complex Acts of knowing: paradox and descriptive self awareness, *Paper presented at European Conference on Knowledge Management*, Dublin.

Snowden, D & Boone, M. (2007). *A leaders' framework for decision making*. Harvard Business Review.

Spender, J. & Scherer, A. (2007). The philosophical foundations of knowledge management: Editor's introduction, *Organization*, 14(5), 5-28.

Spool, J., Scanlon, T., Schroeder, W., Snyder, C. & DeAngelo, T.(1999). *Web site usability, a designer's guide*. San Francisco. CA: Morgan Kaufmann Publishers Inc.

Steeple, C & Jones, C. (Eds). (2002). *Networked learning: perspectives and issues*. London; New York; Springer, c2002.

Stern, J. (2002). *Web metrics: Proven methods for measuring web site success*. New York, NY: Wiley Publishing.

Stevens, R. (2000). Divisions of labor in school and in the workplace: Comparing computer and paper-supported activities across settings. *Journal of the Learning Sciences*, 9(4), 373-401.

Stokes, J.T.& Richey, R.C. (2000). Rapid prototyping methodology in action: A developmental study. *Educational Technology and Development*, 48(2), 63-80.

Sveiby, K. (1996). The Knowledge Organisation.

<http://www.sveiby.com/articles/KOS1.html>. Accessed on the 24th November 2011

Sveiby, K. (1996). What is Knowledge Management? Retrieved October 5, 2012 from <http://sveiby.com/articles/knowledgeManagement.html>

Sweller, J. (1988). Cognitive load during problem solving: Effects on learning. *Cognitive Science*, 12, 257-285.

Sweller, J. (1993). Some cognitive processes and their consequences for the organization and presentation of information. *Australian Journal of Psychology*, 45, 1-8.

Tan, G.W, & Wei, K.K. (2006). An empirical study of web browsing behaviour: towards an effective website design. *Electronic Commerce Research and Applications*, 5(4), 261-271.

The Design-Based Research Collective (2003). Design-based Research: An Emerging Paradigm for Educational Enquiry. *Educational Researcher*, 32(1), 5-8.

Thompson, P & Thompson, A. (1996). Talking about rates conceptually, part II: Mathematical knowledge for teaching. *Journal for research in Mathematics Education*, 27, 2-24.

Thompson, M. & Walsham. G. (2001). Learning to value the bardic tradition: Culture, communication and organizational knowledge. In S. Smithson, J. Gricar, M.

Podlogar and S. Avgerinou. (Eds). Proceedings of the 9th conference on information systems, pp706-714, Krantz, Slovenia.

Timperley, H.S.(2008). 'A Distributed Perspective on Leadership and Enhancing Valued Outcomes for Students'. *Journal of Curriculum Studies*, 40(6), 821-833, 2008.

Timperley, H., Wilson, A., Barrar, H. & Fung, H. (2007). Teacher Professional Learning and Development: Best evidence synthesis Iteration (BES).

<http://educaioncounts.edcentre.govt.nz/goto/BES>

Townley, C. (2003). Will the academy learn to manage knowledge? *Educause Quarterly*, 2:8-11.

Treffers, A. (1987). Three dimensions, A model of goal and theory description in mathematics education: in *Acta Psychologica*, 43, 1-13.

Tripp, S. & Bichelmeyer, B. (1990). Rapid prototyping: An alternative instructional design strategy. *Educational Technology Research & Development*, 38(1), 31-44.

Tschofen, C & Mackness, J. (2012). Connectivism and dimensions of individual experience. *The International Journal of Review of Research in Open and Distance Learning*, 13(1). 124-143.

Tu, C., Blocher, M. & Roberts, G.(2008). Constructs for Web 2.0 learning environments: A theatrical metaphor. *Educational Media International*, 45(4), 253-269..

Tyndale, P. (2002). A taxonomy of Knowledge Management software tools: origins and applications. *Evaluation and Program Planning*, 25, 183-90.

Van Winkelen, C. & Ramsell, P. (2003). Why aligning value is key to designing communities. *KM Review*, 5(6), 12-18.

Venkatesh, V. (2000), "Determinants of perceived ease of use: Integrating control, intrinsic motivation, and emotion into the technology acceptance model", *Information systems research* 11(4), 342-365.

Venkatesh, V. & Bala, H. (2008). Technology acceptance model 3 and a research agenda on interventions. *Decision Sciences*, 39(2), 271-315.

Venkatesh, V. & Davis, F.D. (2000). "A theoretical extension of the technology acceptance model: Four longitudinal field studies", *Management Science*, 46(2), 186-204.

Venkatesh, V., Morris, M.G., Davis, G.B. & Davis, F.D. (2003), "[User acceptance of information technology: Toward a unified view](#)", *MIS Quarterly*, 27(3), 425-478.

Verhagen, P. (2006). Connectivism: a new learning theory? Retrieved February 20 2013, from: <http://elearning.surf.nl/e-learning/english/3793>

Vestal, W. (2006). CoPs in progress: AQPC and Texas Medical Association. *KM Review*, 9(1), 8-9.

Voight, C. & Swatman, P. (2006). Learning through interaction: improving practice with design-based research. *Interactive Technology and Smart Education*, 3(3), 207-224.

Vogt, C., Kumrow, D. & Kazlauskas, E. (2001). The design elements in developing effective learning and instructional web-sites. Retrieved from:

http://find.galegroup.com/gtx/infomark.do?&contentSet=IACDocuments&type=retrieve&tabID=T002&prodId=PROF&docId=A83034548&source=gale&srcprod=PROF&userGroupName=mlin_c_worpoly&version=1.0

Vonderwell, S. & Zachariah, S. (2005). Factors that Influence Participation in Online Learning, *Journal of Research on Technology in Education*, 38(2), 213-230.

Vygotsky, L. (1978). *Thinking and Speech*, Pullman, New York.

Walsham, G. (2001). "Knowledge management: the benefits and limitations of computer systems", *European Management Journal*, 19(6), 599-608.

Wang, F., Means, T & Wedman, J. (2003). Flying the KITE (knowledge innovation for technology in education) through a case-based reasoning knowledge repository. *On the Horizon*, 11(2), 19-31.

Wang, F. & Hannafin, M. (2005). Design-based research and technology-enhanced learning environments. *Educational Technology Research and Development*, 53(4), 5-23.

Wang, S. & Reeves, T. (2006). The effects of web-based learning environment on student motivation in a high school earth science course. *Education Technology Research and Development*, 55, 169-192.

Way, J. (2008). Practical Applications of Web 2. FYI: *The Journal for the School Information professional*, 12(1), 8-13.

Wayman, L. (2004). Wayfinding systems. *Webesteem Magazine*, 9: accessed 10th July 2012 from http://art.webesteem.pl/9/wyman_en.php

Wells, C & Feun, L. (2007). Implementation of learning community principles: A study of six schools. National Association of Secondary School Principals. NASSP Bulletin 91, 2.

Wenger, E. (1998). *Communities of Practice*, New York: Cambridge University Press.

Wenger, E., McDermott, R. & Snyder, W. (2002). *Cultivating Communities of Practice: A Guide to Managing Knowledge*, Harvard Business School Press, Cambridge.

West, R., Wright, G., Gabbitas, B. & Graham, C. (2006). Reflections from the introduction of blogs and RSS feeds into preservice instructional technology course. *TechTrends*, 50(4), 54-60.

Whipp, J. (2003). Scaffolding Critical Reflection in Online Discussions. *Journal of Teacher Education*, 54(4), 321-333.

White, B. (1993). Thinker tools: Casual models, conceptual change, and science education. *Cognition and Instruction*, 10, 1-100.

White, B & Frederiksen, J. (1998). Inquiry: modeling and metacognition: Making science accessible to all students. *Cognition and instruction*, 16, 3-118.

Wigg, K.M. (1993). Knowledge Management Foundations: Thinking about Thinking – How people and Organizations Create, Represent and Use Knowledge. Schema Press, Arlington TX.

Wiley, D. (2001). Learning Objects: Difficulties and Opportunities. Utah State University. Dissertation for PhD.

Willett, S. & Copeland, L. (1998); Knowledge management key to IBM's enterprise plan, Computer Reseller News, issue 800, 27th July, 1998, pp 1-6.

Williams, R. (2006). Narratives of knowledge and intelligence ... beyond the tacit and explicit. *Journal of Knowledge Management*, 10(4), 81-99.

Williams, S. (1992) Putting Case-Based Instruction into Context: Examples from Legal and Medical Education. *The Journal of the Learning Sciences*, 2(4), 367-427.

Williams, R., Karousou, R. & Mackness, J. (2011). Emergent learning and learning ecologies in Web 2.0. *International review of Research in Open and Distance Learning*, 12(3), 39-59.

Winn, W. (1993). A constructivist critique of the assumptions of instructional design. In T. Duffy, J. Lowyck and D. Jonassen. (Eds). *Designing Environments for Constructivist Learning*, pp163-187. Berlin, Heidelberg, Springer-Verlag.

Wolfenbarger, M. & Gilly, M. (2000). Consumer motivations for online shopping. *Proceedings of the Americas Conference on Information System*, pp1362-1366

Wong, K.Y. & Aspinwall, E. (2004). Characterizing Knowledge Management in the small business environment. *Journal of Knowledge Management*, 8(3), 44-61.

Wyman, L. (2009). Wayfinding systems. *Webesteem art and design magazine*. no.9.

Young, M.F. & McNeese, M.D. (1993). A situated cognition approach to problem solving with implications for computer-based learning and assessment. In G. Salvendy & M. Smith. (Eds). *Human-computer interaction: Software and hardware interfaces*, vol.II (pp825-830). Amsterdam, The Netherlands: Elsevier Science Publ. B.V.

Zack, M.H. (1999). Managing Codified Knowledge, *Sloan Management Review*, 40(4), 45-58.

Zeng, R. & Blasi, L. (2010). *The Quarterly Review of Distance Education*, 11(3), 175-182.

Zhang, P. & Dran, G.M. (2000). "Satisfiers and Dissatisfiers: A Two-Factor Model for website Design and Evaluation," *Journal of the American Society for Information Science*, 51(14), pp1253-1268.

APPENDIX A – PHASE 1 QUESTIONS

1. Describe your use of MyClasses.
2. To what extent have you used MyClasses for inter-teacher and inter-school sharing of knowledge?
3. What features of MyClasses are useful to support teacher knowledge-sharing and learning?
4. What features of MyClasses inhibit teacher knowledge-sharing and learning?
5. What features currently not available would facilitate teacher knowledge-sharing and learning?
6. What on-line resources do you currently access and use to support your learning?
7. What are the features of those sites that meet your needs?

8. What would a diocesan site have to provide in order to be worthwhile to you and under what circumstances would you use it in preference to the sites you are already accessing?
9. What features/functionality would such a site have to provide?
10. What other aspects of using technology for knowledge-sharing are important to you?

APPENDIX B – PHASE 2 QUESTIONS

1. How do users of this site create, edit, share and organise their learning and how useful would the same morphology be for a site developed for teachers within the diocese?
2. How easy is this site to use, both as a user and a contributor?
3. To what extent does this site integrate or limit the learning opportunities offered by Web-2 technology?
4. What social arrangements are supported by this site and what are the implications for a diocesan site?
5. How does this site meet teacher needs for privacy and the issues of trust and intellectual property that teachers say are important to them in deciding whether to contribute?
6. How does this site encourage contributions that are useful to teachers without requiring them to be perfect?

7. What features of this site facilitate learning within the context of teachers' professional growth?
8. Given that teachers are looking for some way to assess the value of contributions submitted to the site, how does this site assess the effectiveness of materials that are provided and how would this meet the needs of teachers in the diocese?

APPENDIX C – TASKS TO BE COMPLETED ON EACH SITE DURING PHASE 2 EVALUATION

1. On your desktop you will find a document called “test – literacy and learning”. With each of the sites that are examined, please upload and download this file.
2. Share the file with the researcher directly from the site:
(jane.comensoli@ceowoll.catholic.edu.au)
3. Create your own new document “test” on the site.
4. Find a group related to literacy or numeracy and join the group.
5. Locate information relevant to your teaching practice in the area of literacy or numeracy.

APPENDIX D – SITES EVALUATED IN PHASE 2

Scribd – <http://www.scribd.com>

EDNA – <http://www.edna.au>

BEST – <http://www.bestedsites.com>

TappedIn – <http://tappedin.org>

Teacher Tube – <http://teachertube.com>

EDUBLOGS – <http://www.edublogs.org>

and

Twitter – <http://twitter.com>

APPENDIX E – ACTIVITIES DURING THE 2-WEEK TRIAL OF THE FIRST PROTOTYPE

Expert Group – LMS Trial Instructions

Trial commences: Tuesday, August 9, 2011.

Trial finishes: Friday, August 26, 2011.

STEP 1: Suggested activities

Either by building upon the site you created on the LMS Expert Group Day, or by creating a new site, **consider doing some or all of the following tasks:**

Activity 1: Creating & configuring your page

- Add a variety of cells and resources to the page.
- Change the background image and re-arrange the cell layout.
- Add a link to an external website or external resource.
- Tag your site with appropriate search tags.
- Upload and embed multimedia files into the system, e.g. YouTube, Vimeo, Quicktime, iMovie, audio files, and so on.
- Using communications tools: RSS, twitter, links, news, posties.
- Create menus and sub-pages.

Activity 2: Working with documents & resources

- Using document tools: uploading and downloading files.
- Create a resource list on your page to display documents & resources.
- Set permissions on documents/resources.
- Managing documents and folders: move, copy, rename, delete.
- Set documents/folders to be accessed only at defined time periods.

Activity 3: Sharing your work

- Set the permissions on your page to share its content with others: other teachers, other students.
- Create links between areas and content, e.g: linking an announcement to content, discussion message, linking from one document to another, etc.
- Search for other resources and link your page to another resource.

Activity 4: Setting student tasks

- Create a wiki, blog, or discussion forum on your site and set permissions to allow students to contribute to these resources.
- Use the learning activity to create a sequence of learning tasks for students.
- Use permissions to assign different users to different tasks (personalised learning).
- Explore student assessment tools using *My Activities & Assessment*, *My Class Tracker*, *My Progress* cells.

APPENDIX F – PARTICIPANT SURVEY – FIRST ITERATION

LMS Trial - Feedback Form

Please use this form to record your experiences with the "Life" LMS during the two-week trial period. We suggest that you complete this survey once you have attempted Activities 1–4 in the LMS Expert Group Trial Instructions.

***Required**

Your name *

Section 1: Using the LMS as a teacher

Please answer the following questions with regard to the ease of use of the "Life" LMS

1.1 Overall, I have found the Life LMS to be *Choose one only

- ☐ Difficult to use
- ☐ Mostly difficult to use, with some parts easier to follow
- ☐ OK to use – some parts easy, some parts difficult
- ☐ Mostly easy to use, with some parts difficult to follow
- ☐ Easy to use

1.2 Please rate the following aspects of the Life LMS with regard to how easy or difficult it is to use *

	Very poor	Poor	OK	Good	Very Good
Navigation within the learning space	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Creating a learning space	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Logical flow of the system	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
"Look & feel" of the user interface	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ability to customise a learning space	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

	Very poor	Poor	OK	Good	Very Good
Ability to share a learning space with others	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The number of "clicks" required to achieve a task	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

1.3 Please describe your overall impressions of the Life LMS with regard to ease of use. Please comment on the overall 'intuitiveness" of the system, if you think the LMS is easy to grasp and learn, and how you think your teaching colleagues might respond to the ease or difficulty of the system *

Section 2: Using the LMS as a student

The following questions capture your feedback around the user experience with the Life LMS from the perspective of a student. If your students did not have the opportunity to use the system, please use your judgement to gauge their responses to the questions below.

2.1 Please rate how you think your students would respond (or did respond) to the Life LMS according to the following aspects: *

	Very poor	Poor	OK	Good	Very Good
"Look & feel" of the user interface	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
How engaging they would find the space	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ease of navigation within the learning space	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

	Very poor	Poor	OK	Good	Very Good
As a tool for managing their learning	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
As a creative tool to express themselves	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
As a way to collaborate with peers	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

2.2 Please describe your thoughts on the overall effectiveness of the system from a student's perspective. *

Section 3: Building a virtual learning environment

Please provide your feedback on the system's ability to build a virtual learning environment, personalise learning, create and manage learning tasks, and collaborate with others.

3.1 You had the opportunity to do a number of activities with the Life LMS. Please describe your experiences with the system as you attempted various tasks (i.e. suggested activities 1–4) *

3.2 Thinking about the various tools and functions available in the system, please rate your experience in using these tools in the table below *

	Poor	OK	Good	Don't know/Didn't use
Creating a virtual learning space	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ability to personalise learning	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Searching for digital resources in the Life LMS	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Sharing digital resources with colleagues	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Communication tools (e.g. news feeds, twitter, announcements)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Creating a learning sequence	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Assessing student work	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Embedding other Web 2.0 tools	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Wiki tool	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Blogging tool	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Discussion Forum tool	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Working with multimedia (images, audio, video)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Section 4: Implementation questions

The following questions ask you to reflect on how the Life LMS might be implemented at your school and across other CEO Sydney schools.

4.1 Please describe the professional development you think would be necessary to help your colleagues get started with the Life LMS. Please consider two aspects: 1. the amount of time needed; and 2. the style of delivery (instructor-led, online, peer-to-peer, in-classroom, video conference,

etc) *

4.2 Thinking about the strengths and weaknesses at your school that might impact the adoption of the Life LMS by teachers, please rate the following aspects: *

	A major weakness	A weakness	Neither a weakness nor a strength	A strength	A major strength
Staff access to their own personal technology (e.g. laptop)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Leadership of school executive	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Leadership of KLA Co-ordinators	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Contemporary pedagogy competence	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Staff ICT competence	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The level of ICT technical support	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The reliability of school ICT resources	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Internet bandwidth	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

4.3 Assuming the LMS would be optional for teachers to use in their classroom, how do you think your teaching colleagues would respond to the LMS? *

- ☐ Most would not use it

- ☐ Some would use it effectively, but many would not use it
- ☐ Roughly half would use it effectively and half would not
- ☐ Many would use it effectively, but some would not use it
- ☐ Most would use it effectively

4.4 For my school(s), I would recommend: *

- ☐ We don't adopt the Life LMS
- ☐ We don't adopt the Life LMS and continue to use our local solution(s)
- ☐ We adopt the Life LMS but continue to use our local solution(s)
- ☐ We adopt the Life LMS and discontinue use of our local solution(s)

4.5 Would you recommend that CEO Sydney adopt the Life LMS for implementation across all schools? *

- ☐ No
- ☐ Yes
- ☐ Undecided

4.6 Optional closing comments

Submit

Never submit passwords through Google Forms.

Powered by [Google Docs](#)[Report Abuse](#) - [Terms of Service](#) - [Additional Terms](#)

classroom management

Another excellent [Edublogs.org](#) weblog

[Home](#)

[About](#)

[Best Practice Statement](#)

[Case Study](#)

[Positive Behaviour management](#)

Best Practice Statement

Best Practice Statements are intended to describe best practice in a particular area and to act as a guide to professionals. This practice statement relates to the assessment of antecedent conditions when setting up a positive behaviour management strategy in the classroom.

1. Teachers are knowledgeable about their students.

Use observations and record keeping to check your assumptions about students. For behaviour concerns useful observations would include some or all of the following: social interactions within the class; levels of engagement across different KLAs or across different teaching delivery methods; times of day when class is settled. As changes are made, the result can be assessed against baseline data to determine whether it makes a difference to behaviour in the class.

2. Room Arrangement is Critical.

The physical structure of the classroom, including seating arrangements, will influence positive behaviour management. Work groups of 4s and 6s are not conducive to a high level of academic interaction (Bennett and Blundell, 1983). Seating in rows will encourage individual on-task behaviour but restrict group work. Other configurations to consider would be 3s, horseshoe, etc. [Classroom seating on You Tube](#)

3. Teaching Strategy.

Responsibility is taught by giving responsibility. Encouraging children to work independently requires a facilitative role for the teacher. To establish the parameters students are engaged in discussing issues of classroom organisation and decision-making.

4. Climate for Co-operative Learning.

classroom management

Another excellent Edublogs.org weblog

[Home](#)

[About](#)

[Best Practice Statement](#)

[Case Study](#)

[Positive Behaviour management](#)

Case Study

[classroom conditions](#) Tagged [Desk organisation](#) March 7, 2009

My year 5 class was very demanding – their work output was low and students were often off task, I was spending a lot of time asking for work to be handed in, sorting out squabbles, and telling students to sit and finish their work. Even when I set a simple task the students would ask a lot of questions and seek a lot of direction throughout. My first response was to move the student tables from clusters to rows as I thought that would reduce distractions and allow students to concentrate better. I tried this for a week but the dynamics didn't change. I decided to keep a record of what was happening in the class by keeping a simple observation sheet and I compared a teacher directed session to a self-directed session. I found that the level of interruption and questioning was higher in the formal lesson. I decided to create a class structure that allowed for a more controlled way for students to exchange ideas and I adopted a horseshoe arrangement. This has totally changed the dynamics as it allows individual work to be uninterrupted, but group work to take place. Chairs can be brought within the horseshoe for circle discussion, and the free space in the middle can be used for drama and demonstration. The change has totally changed the dynamics of my classroom.

[Edit](#)

classroom management

[Another excellent Edublogs.org weblog](#)

[Home](#)

[About](#)

[Best Practice Statement](#)

[Case Study](#)

[Positive Behaviour management](#)


Positive Behaviour management

Positive Behaviour Management focuses on building up a positive atmosphere by involving the student as a partner in the educational process. It emphasises the need to give every pupil the opportunity to develop self-discipline through appropriate learning experiences. Pupils may be invited to set positive learning goals with the teachers and monitor and record their own progress.

Positive behaviour management relies on appropriate behaviour being rewarded and inappropriate behaviour ignored where possible to avoid reinforcement of poor behaviour through extra attention from teachers or students, “privileges” such as time out etc. The challenge for a teacher in setting up a positive behaviour environment is to create the conditions that invite positive behaviours.

Sometimes there are other conditions operating that impact on the behaviour of students in their classroom. Known as antecedent conditions, these include the physical aspects of the classroom, teaching strategy, the learning climate of the classroom and the role of the teacher. To see how these link together, you can read a case study of a year 5 classroom, or review the best practice guide.

APPENDIX H - ETHICAL ISSUES – ETHICS APPROVAL HE08/150

<hr/>	
University of Wollongong 	
<hr/>	
INITIAL APPLICATION APPROVAL In reply please quote: HE08/150 Further Enquiries Phone: 4221 4437	
30 June 2008	
Mrs J Comensoli Catholic Education Office LMB 8802 Wollongong NSW 2500	
	
Dear Mrs Comensoli	
Thank you for your response dated 23 June 2008 to the HREC review of the application detailed below. I am pleased to advise that the application has been approved.	
Ethics Number:	HE08/150
Project Title:	Development of a knowledge management system within the system of schools comprising the catholic education office diocese of Wollongong
Researchers:	Mrs J Comensoli, A/Professor N Bhindi, A/Professor A Herrington
Approval Date:	26 June 2008
Expiry Date:	25 June 2009
The University of Wollongong/SESIAHS Humanities, Social Science and Behavioural HREC is constituted and functions in accordance with the NHMRC <i>National Statement on Ethical Conduct in Human Research</i> . The HREC has reviewed the research proposal for compliance with the <i>National Statement</i> and approval of this project is conditional upon your continuing compliance with this document. As evidence of continuing compliance, the Human Research Ethics Committee requires that researchers immediately report:	
<ul style="list-style-type: none">• proposed changes to the protocol including changes to investigators involved• serious or unexpected adverse effects on participants• unforeseen events that might affect continued ethical acceptability of the project.	
You are also required to complete monitoring reports annually and at the end of your project. These reports are sent out approximately 6 weeks prior to the date your ethics approval expires. The reports must be completed, signed by the appropriate Head of School, and returned to the Research Services Office prior to the expiry date.	
Yours sincerely	
Dr Nadia Crittenden Acting Chairperson Human Research Ethics Committee	
cc A/Professor Narottam Bhindi, Education	
<hr/>	
Research Services Office University of Wollongong NSW 2522 Australia Telephone: +61 2 4221 3386 Facsimile: +61 2 4221 4338 research_services@uow.edu.au www.uow.edu.au/research <small>©2008 Provider No. 001026</small>	