The influence of case-based reasoning on principals' beliefs about teaching with information and communication technologies

Thomas L. Otto
Withcott State School
tom.otto@eq.edu.au

Peter R. Albion
Faculty of Education, University of Southern Queensland
albion@usq.edu.au

Abstract

Research suggests there are barriers to principals developing new beliefs and understandings that support a vision of teaching with information and communications technology (ICT). Many principals have not taught with the new technologies and are maintaining print based pedagogies while exploring new pedagogies appropriate to the information age.

In a previous study (Otto, 2003), the researcher concluded that in order to change principals' beliefs about teaching with ICTs, it is necessary to confront old beliefs with new beliefs. His case study of three Queensland primary principals highlighted uncertainties amongst practitioners about what those new beliefs should be. That is, the principals were inconsistent in describing the exemplary use of ICTs in classrooms. It was also noted in the study that the "real world" of the classroom imposed limitations on the implementation of practices recommended in the literature and the vision that teachers and principals have of the ideal classroom.

A second study is proposed to investigate the influence of case-based reasoning on principals' beliefs about teaching with ICTs. The design, development, implementation, and institutionalisation of a prototype multi-media project that employs a case library to support Case-Based Reasoning (CBR) principles will be evaluated. The case library will be compiled of case stories derived from contemporary thinking about best practices in teaching with ICTs and the stories of principals in the field.

Introduction

The Queensland Government (2002) recognises that "ICTs [Information and Communications Technologies] are absolutely fundamental in this new knowledge age and for the Smart State," and that "our students must have highly trained teachers who know how to use technologies in the classroom" (p. 2). To support this view, the Queensland government released funding in 2003 to improve the ICT infrastructure in classrooms. As well, Education Queensland, the department responsible for managing schools and implementing education policy, requires teachers to be equipped with the skills to both use ICTs and teach with ICTs, and requires principals to develop plans for the effective use of ICTs in management and learning. (Education Queensland, 2002)

The Roles of Principals

Ainley, Banks & Fleming (2002) agree that the provision of ICT resources needs to be supported by a focus on teaching and leadership. Baylor & Ritchie (2002) add that

> administrators who promote the use of technology, not only in words but in actions, lend credence to a technology culture. . . . By helping teachers find ways to actively infuse technology, investments in time and money will pay off in greater content acquisition and higher-order thinking skills for students and greater teacher competence and morale. (pp. 412-413)

The critical roles principals have in supporting and guiding teaching and learning with ICTs in their schools include

1. the development and communication of a vision;
2. the planning and implementation of policy;
3. modelling the use of ICTs;
4. modelling the teaching of ICTs;
5. managing resources; and
6. co-ordinating staff development. (Meltzer & Sherman, 1997; Gibson, 2001; Hope, Kelley & Guyden, 2000; Bennett, 1996; Mize & Gibbons, 2000; Baylor & Ritchie, 2002)

The development and communication by principals of a vision is a key role, which impacts on each of the other five roles. That is, principals' beliefs about teaching with ICTs and their vision for technology integration influences their planning and the way they model the use of ICTs, manage resources, and prioritize staff development.

The Problem

In a previous study (Otto, 2003), concerns were raised that principals may be uncertain in their beliefs about teaching with ICTs. The three principals who participated in the study were inconsistent in describing the exemplary use of ICTs in classrooms. They had limited experience in teaching with ICTs and did not have access to this technology during their formative years as teachers. It was also noted in the study that the "real world" of the classroom imposed limitations on the implementation of practices recommended in the literature and what teachers and principals believe to be an ideal learning environment. This uncertainty about what constitutes exemplary practice and the constrictions on implementing exemplary practices are reflected in the following issues raised in the previous study (Otto, 2003).

1. How should knowledge be managed in the classroom?
2. How does a teacher's view of knowledge influence their approach to teaching?
3. How should traditional approaches to teaching be balanced with constructivist compatible theories of learning?

4. How should print-based pedagogies be balanced with ICT based pedagogies?
5. What software is appropriate and how should it be used?
6. How should children's access to ICTs be organised?
7. How does the personal use of ICTs relate to teaching with ICTs?
8. How should learning objectives and the curriculum be organised?
9. How should teachers evaluate their teaching with ICTs?
10. How should the use of ICTs change with the age of the children?
11. How should the use of ICTs change when teaching children from different socio-economic backgrounds?

Teachers' beliefs play a fundamental role in what they do in their classrooms, including their beliefs about children, teaching, ICTs, and what teachers envisage as being exemplary teaching with ICTs (Carlson, 1994 in Meredyth, Russell, Blackwood, Thomas & Wise, 1999). According to Ertmer (1999), factors that are intrinsic to teachers, including "beliefs about teaching, beliefs about computers, established classroom practices, and unwillingness to change" (p. 48), are potential barriers to technology integration. Developing shared understandings and beliefs within the school community is a central process in Hill & Crévola's (1997) general design for improving learning outcomes. Therefore, principals must be confident in their beliefs about exemplary teaching with ICTs if they are to contribute to the development of shared understandings and beliefs and if they are to provide leadership in the integration of technology appropriate to the needs of learners (Meredyth et al., 1999; Robyler, 1993; Ertmer, 1999; Albion & Ertmer, 2002).

Albion & Ertmer (2002) believe the "working conditions of many teachers restrict their opportunities for observing alternative classroom practices" and say that "suitable models for observation are not widely available" (p. 36). They argue that "approaches are needed that expose teachers to alternative visions of teaching and offer them opportunities to test their ideas without risk to the progress of their students" (p. 36). While Albion & Ertmer refer to teachers, the same situation applies to principals. This paucity of models of teaching with ICTs that principals and teachers can readily access as exemplars was also noted in the previous study (Otto, 2003).

The researcher (Otto, 2003) proposed a model to engage principals in taking on new beliefs and in doing so develop a vision for teaching with ICTs (see Appendix A). The model was based on four sources of information that influence self-efficacy (Bandura, 1986). That is, principals would observe the behaviour, enact the behaviour, be persuaded of the benefits of the behaviour, while at the same time attend to affective influences, such as their skill to operate ICTs efficiently. Within this model, there is a need for a resource that exposes principals to exemplars in teaching with ICTs, and a strategy that supports principals in building on their own experiences and the experiences of others as they solve problems and reflect on issues. This paper outlines a proposal for a second study to investigate the usefulness of a prototype multi-media project based on the principles of case-based reasoning in meeting this need.

Objective of the Study

The objective of the study is to investigate the influence of case-based reasoning on principals' beliefs about teaching with ICTs. The design, development, implementation, and institutionalisation of a prototype multi-media project that employs a case library to support Case-Based Reasoning (CBR) principles will be evaluated. The case library will be compiled of case stories derived from contemporary thinking about best practices in teaching with ICTs and the stories of principals in the field.

Case-Based Reasoning

Kolodner & Leake (1996) are two of the early authors in the field and they provide this summary of case-based reasoning.

> Case-based reasoning means reasoning based on previous cases or experiences. A case-based reasoner uses remembered cases to suggest a means of solving a new problem, to suggest how to adapt a solution that doesn't quite work, to warn of possible failures, to interpret a new situation, to critique a solution in progress, or to focus attention on some part of a situation or problem. (p. 31)

Case-based reasoning (CBR) is suited to influencing beliefs about teaching with ICTs because it is cyclic in nature. That is, learning is viewed as an on-going process and it adapts well to the problem of evolving technologies and the changing needs of learners. Jonassen & Hernandez-Serrano (2002) describe this cyclic nature of CBR.

An encountered problem (the new case) prompts the reasoner to retrieve cases from memory, to reuse the old case (i.e., interpret the new in terms of the old), which suggests a solution. If the suggested solution will not work, then the old and or new cases are revised. When the effectiveness is confirmed, then the learned case is retained for later use. (p. 71)

Since its development and infusion in technology mediated environments in the late 1980's and early 1990's, case-based reasoning has found a multitude of applications. Its principles are driving help desk programs, call centre operations, medical diagnosis software, and planning for armed conflict, and represent a new approach to machine learning otherwise known as artificial intelligence. The function of case-based reasoning within these programs is more than likely invisible to the user. Despite an extensive impact in the fields of commerce, defence, medicine, law, and others, there appears to be little transference of case-based reasoning to applications in the professional learning of educators. (Kolodner & Leake, 1996; Aamodt & Plaza, 1994; Kolodner, 1993). This prototype multi-media project is an innovative use of an emerging technology in a field to which it should be well suited.

Furthermore, rather than relegating case-based reasoning to the role of an invisible driver within the project, it is intended to make the principles known to the user. That is, case-based reasoning is also a memory system and a way of organising and making sense of events and experiences in order to cope with new situations (Schank, 1996). Therefore, principals who model their learning on case-based reasoning may be in a better position to deal with the conflicting messages and ambiguous demands relating to teaching with ICTs.

Case Libraries

Case libraries support case-based reasoning by providing a store of cases the reasoner may draw on when faced with a new situation. As in the traditional notion of a library, the case stories and elements of the case stories are catalogued or indexed to facilitate retrieval. (Jonassen & Herandez-Serrano, 2002)

There are additional benefits to designing the project around case stories. For example, case stories provide a context in which principals may actively participate in realistic problem situations similar to their everyday experiences (Ertmer & Dillon, 1998). Sharing stories may not only enhance principals' knowledge of successful practices, but principals may also feel part of a learning community and derive comfort from knowing others are facing similar challenges. Story is a useful means for principals to share their beliefs with teachers, because storytelling "encourages others to listen, to share, and to empathize" (Riessman, 2002, p. 697). A further attraction is that story has the potential to guide action (Drake, Spillane & Hufferd-Ackles, 2001; Atkinson, 2002).

Content of the Case Library

In selecting an area on which to base the content of the case library for the prototype multimedia project, consideration was given to an innovation

1. in which technology plays a substantial role;
2. that shows evidence of significant changes in roles of teachers and students, the goals of the curriculum, and/or the educational materials or infrastructure;
3. that shows evidence of measurable positive student outcomes; and
4. that is sustainable and transferable. (Kozma & Anderson, 2002, p. 389)

The development of student digital portfolios not only meets these criteria, but was selected for other reasons as well. Documenting or developing pilot environments for digital portfolios is one of five nominated categories in the 2003 ICT Innovators Grants application (Queensland Government, 2003), with up to $20000 available for an individual school and $50000 for a cluster of schools. There are Queensland primary principals who are already experimenting with and developing practices and frameworks relating to digital portfolios. Others will be faced with the concept for the first time if their Innovators Grants applications are successful, and others still will consider implementing digital portfolios when the outcomes of the innovators projects become known. That is, a target audience for the prototype multimedia project already exists and is likely to expand over the next few years. Furthermore, because student digital portfolios are in a multimedia format, exemplars may be readily transferred to the case stories.

Student Digital Portfolios

Wiedmer (1998) defines a digital portfolio as "a purposeful collection of work, captured by electronic means, that serves as an exhibit of individual efforts, progress, and achievements in one or more areas" (p. 586). Wiedmer (1998) goes on

to outline some of the issues principals will need to address as they manage the implementation of digital portfolios in their schools. Approaches to teaching will need to engage students in making the choices that digital portfolios allow, and to encourage students to reflect on their decisions. These options afforded by the multimedia formats in digital portfolios require thoughtful planning, an element of creativity, and a willingness to innovate. The purpose for the portfolios will also need to be considered. It is rather pointless to invest time, effort, and expense in producing portfolios if they are not being reviewed or contribute to learning. As with any ICT related topic, staff and student access and skills in using the hardware and software will be an ongoing factor.

Building the Case Library

Jonassen & Herandez-Serrano (2002, p. 71) propose these four steps to build case libraries: (a) identify skilled practitioners; (b) show problems to the practitioners; (c) have the practitioners recount their solutions to similar problems; and (d) decide what the stories teach.

Participant identification

Principals will be selected to participate in the study because of their experiences with digital portfolios, rather than their expertise (Jonassen & Herandez-Serrano, 2002). That is, the focus will be on the processes, successes, and challenges principals experienced as they faced a new situation.

Presentation of problems

Participants would be presented with issues that principals are likely to encounter if they are managing the development of student digital portfolios in their schools. Some of these issues are discussed by Klenowski (2002), including

1. identifying the purpose of the portfolio;
2. selecting work for inclusion;
3. involving students in the assessment process;
4. student self-evaluation;
5. determining what is valued in assessment;
6. integrating assessment with the curriculum, teaching and learning;
7. identifying authentic learning tasks; and
8. reflecting on the strategies and processes in such learning (p. 27)

Recount of solutions to the problems

On being presented with the problems, the participants will recount how they have solved similar problems. There is an opportunity at this stage of the data collection process for the researcher to employ a range of techniques that will enrich the case stories. The five techniques described by Calderhead (1996) will be useful as these relate to collecting data about knowledge, beliefs, and thinking relating to teaching.

First, simulations using video excerpts or other contrived situations can elicit responses. Second, commentaries may involve principals thinking aloud as they solve problems or try to recall their thinking as they watch a video of teaching. Third, in concept mapping or repertory grid, principals develop a list of concepts from brainstorming, indicate how the concepts are inter-related, and then name those relationships. Fourth, ethnography and case studies focus on an individual principal through observation and interviews. Fifth, principals may provide narrative accounts of their work. Documents may also be collected, analysed, and copied as examples of how principals have solved problems. These may include teachers' preparation, children's work, checklists, tests, policies, and schedules.

Indexation of the stories

The stories will be indexed to facilitate retrieval, and Jonassen & Herandez-Serrano (2002) provide examples of index categories and indexes to facilitate this task (see Table 1).

Table 1: Indexation of the Stories

Index Categories	Indexes
Problem-situation-topic Indexes	What were the goals-subgoals-intentions to be achieved in solving the problem or explaining the situation?
	What constraints affected those goals?
	Which features of the problem situation were most important and what was the relationship between its parts?
	What plans were developed for accomplishing goals?
Appropriate Solution Indexes	What solution was used?
	What activities were involved in accomplishing the solution?
	What were the reasoning steps used to derive the solution?
	What expectations did you have about the results?
	What acceptable, alternative solutions were suggested but not chosen?
	What unacceptable, alternatives solutions were not chosen?
Appropriate Outcomes Indexes	Was the outcome fulfilled?
	Were expectations violated?
	Was the solution a success or failure?
	Can you explain why any failures occurred?
	What repair strategies could have been used?
	What could have been to repair the problem?

While the indexation process provides one aspect of the analysis of the stories, there will also be a need to analyse the stories in reference to contemporary practices identified in the literature.

Design of the Multi-Media Project

The prototype multi-media project should be viewed as more than a vehicle to facilitate the retrieval of case stories. That is, the reasons for selecting a computer-mediated environment for the presentation of cases go beyond the efficiencies of key word searches. For example, the multi-media component provides much greater contextual detail for the case stories than would be possible by text alone. While case-based reasoning may be the central organising principle in the design of the project, to maximize the potential of the project as a learning environment there are other principles that will also be considered.

First, there are the principles relating to the design of the media, including the design of the application, selection of the media and authoring facility, the development of story boards, and art renditions (Bergman & Moore, 1990). The usability of the project will be a factor in both design and evaluation (Nielsen, 1994).

Second, there are the principles relating to the instructional design of the project. Constructivist principles will be a feature, with an emphasis on "situating cognitive experiences in authentic activities" (Duffy & Jonassen, 1992, p. 4). As well, knowledge construction supported by case-based reasoning will be a focus, rather than the acquisition of specific learning outcomes. What is important is not what the principals know, but for them to be able to construct plausible interpretations and alternative perspectives and interpretations (Cunningham, 1992). Another consideration is the development of an awareness of process (Bednar, Cunningham, Duffy & Perry, 1992). That is, principals will be made aware of the process of learning in the multi-media project. Case-based reasoning will be explained with encouragement and opportunities for principals to practice the process in other arenas. The richness of the context is another important aspect in constructivism, and allows the learner to work with a concept in a complex environment (Spiro, Feltovich, Jacobson & Coulson, 1992).

Evaluation of the Project

As technology mediated learning environments have grown with advances in technology and its proliferation, there has been a commensurate need to evaluate those learning environments. Universities need to evaluate the cost effectiveness and benefits to students of multi-media programs designed to support courses. Software engineers need to assess the usability and profit potential of their products, and government-funded projects require reports to justify expenditure. The literature provides many examples of such evaluations of varying types and quality. For example, Alexander & McKenzie (1998) evaluated 104 projects that received funding from the Committee for the Advancement of University Teaching (CAUT).

However, Jonassen & Herandez-Serrano (2002) report, "very little empirical research on the role of stories in problem solving has been conducted. Most of the research in Case-Based Reasoning has been conceptual and developmental." (p. 70) Furthermore, Bain (1999) describes concerns that evaluations of innovations in higher education "were of limited scope and quality" (p. 165), particularly in the attention given to learning processes and learning outcomes.

Evaluation Framework

In recognition of this need to evaluate innovative technology mediated learning environments, Bain (1999) invited article contributions to a special edition of the Higher Education Research and Development (HERDSA) journal. Bain (1999) selected five articles from the 16 submitted, but determined that "no single article employs the full range of evaluation criteria, but collectively they illustrate most aspects that should be considered" (p. 166). It is this integrated approach, as adapted in Appendix B, that forms the evaluation framework for this project.

The comprehensiveness of the framework is demonstrated in the attention given to all stages of the project. That is, information is collected during the four phases of design, development, implementation, and institutionalisation. The Australian Government Committee for University Teaching and Staff Development funded a report (Phillips, 1999) in which the framework was applied in the evaluation of 20 multi-media projects developed and implemented in universities across Australia to support student learning. The report provides exemplars of computer-facilitated learning projects as well as demonstrating the application of the evaluation framework proposed for this study.

There is flexibility within the framework to add other evaluation techniques relevant to the project. For example, principals would need to be self-regulated or self-motivated to participate in the project, engage in the activities, and take on new learning. An evaluation process proposed by Ertmer, Newby & MacDougall (1996) is based on the assumption that self-regulation is a key factor in case-based learning. Three elements of self-regulation offer focal points for data collection, including participants'

1. interest in and valuing of the project;
2. perceptions of their competence to complete the project; and
3. focus on the underlying learning processes rather than project outcomes.
4. (p. 722)
5. Self-reporting learning inventories include the Motivated Strategies for Learning Questionnaire (MSLQ) (Pintrich, Smith, Garcia & McKeachie, 1991) and the Self-Regulated Learning Inventory (SRLI) (Lindner & Harris, 1992).

Usability is another factor to be considered in the design and evaluation of the project, and "refers to how easy it is for users to learn a system, how efficiently they can use it once they have learned it, and how pleasant it is to use" (Mack & Nielsen, 1994, p. 3). The proposed usability inspection method for the project is an heuristic evaluation, which involves a sample of "evaluators examin[ing] the interface and judg[ing] its compliance with recognized usability principles (the "heuristics")" (Nielsen, 1994, p. 26). These usability principles may include

1. simple and natural dialogue;
2. speak the users' language;
3. minimize the users' memory load;
4. consistency;

5. feedback;
6. clearly marked exits;
7. shortcuts;
8. precise and constructive error messages;
9. prevent errors; and
10. help and documentation. (Nielsen, 1994, p. 29)

The evaluation of the project is an integral part of its design, development, implementation, and institutionalisation. For example, usability and the motivation of principals need to be considered in the development of the project, and are also a part of the evaluation process. Furthermore, the range of information sources at the different stages serves to triangulate and validate data.

Summary

It is anticipated that the data obtained from the study will open up new lines of inquiry about best practices in teaching with ICTs, as well as guide principals as they support teaching and learning in their schools. The project represents a unique application of case-based reasoning with implications for its use in other areas of professional learning in the field of education. It is intended that the study will result in a high quality, marketable product that is useful for principals in leading and managing change in their schools.

Reference List

Aamodt, A, & Plaza, E. (1994). Case-based reasoning: Foundational issues, methodological variations, and system approaches. Artificial Intelligence Communications, 7(1), 39-59.

Ainley, J., Banks, & Fleming, M. (2002). The influence of IT: Perspectives from five Australian schools. Journal of Computer Assisted Learning, 18, 395-404.

Albion, P.R., & Ertmer, P.A. (2002). Beyond the foundations: The role of vision and belief in teachers' preparation for integration of technology. Tech Trends, 46(5), 34-38.

Alexander, S., & McKenzie, J. (1998). An evaluation of information technology projects for university learning. Canberra: Australian Government Printing Service.

Atkinson, R. (2002). The life story interview. In J.F. Gubrium, & J.A. Holstein (Eds.), Handbook of interview research: Context and method (pp. 121-138). Thousand Oaks: Sage.

Bain, J. D. (1999). Introduction to the special issue on evaluation of innovations. Higher Education Research & Development, 18(2), 165-172.

Bandura, A. (1986). Social foundation of thought and action: A social cognitive theory. Englewood Cliffs, N.J.: Prentice-Hall.

Baylor, A.L., & Ritchie, D. (2002). What factors facilitate teacher skill, teacher morale, and perceived student learning in technology-using classrooms. Computers & Education, 39, 395-414.

Bednar, A.K., Cunningham, D., Duffy, T.M., & Perry, J.D. (1992). Theory into practice: How do we link? In T. Duffy, & D. Jonassen (Eds.), Constructivism and the technology of instruction: A conversation pp. 17-34. Hillsdale, N.J.: L. Erlbaum.

Bennett, C.K. (1996). Schools, technology, and educational leadership: A framework for change. NASSP Bulletin, 80, 57-65.

Bergman, R.E., & Moore, T.V. (1990). Managing interactive video/multimedia projects. Englewood Cliffs, N.J.: Educational Technology Publications.

Calderhead, J. (1996). Teachers: Beliefs and knowledge. In D.C. Berliner, & R.C. Calfee (Eds.), Handbook of educational psychology (pp. 709-725). New York: Simon and Schuster Macmillan.

Cunningham, D.J. (1992). Assessing constructions and constructing assessments: A dialogue. In T. Duffy, & D. Jonassen (Eds.), Constructivism and the technology of instruction: A conversation pp. 17-34. Hillsdale, N.J.: Lawrence Erlbaum.

Drake, C., Spillane, J.P., & Hufferd-Ackles, K. (2001). Storied identities: Teacher learning and subject-matter context. Journal of Curriculum Studies, 33(1), 1-23.

Duffy, T., & Jonassen, D. (1992). Constructivism: New implications for instructional technology. In T. Duffy, & D. Jonassen (Eds.), Constructivism and the technology of instruction: A conversation pp. 1-16. Hillsdale, N.J.: L. Erlbaum.

Education Queensland (2002). ICTs for learning: School information kit 2002-2003. Brisbane: The State of Queensland.

Ertmer, P.A. (1999). Addressing first- and second-order barriers to change: Strategies for technology integration. Educational Technology Research and Development, 47(4), 47-61.

Ertmer, P.A., & Dillon, D.R. (1998). 'Shooting in the dark' versus 'breaking it down': Understanding students' approaches to case-based instruction. International Journal of Qualitative Studies in Education, 11(4).

Ertmer, P.A., Newby, T.J., & MacDougall, M. (1996). Student's responses and approaches to case-based instruction: The role of reflective self-regulation. American Educational Research Journal, 33(3), 719-752.

Gibson, I.W. (2001). The role of school administrators in the process of effectively integrating educational technology into school learning environments: New research from the mid-west. Paper presented at the Society for Information Technology in Education International Conference (12th, Orlando, FL, March 5-10).

Hill, P.W., & Crévola, C.A. (1997). Key features to a whole-school, design approach to literacy teaching in schools. Available: http://www.sofweb.vic.edu.au/eys/pdf/hillcrev.pdf

Hope, W.C., Kelley, B., & Guyden, J.A. (2000). Technology standards for school administrators: Implications for administrator preparation programs. Paper presented at the Society for Information Technology in Education International Conference (11th, San Diego, CA, February 8-12).

Jonassen, D.H., & Hernandez-Serrano, J. (2002). Case-based reasoning and instructional design: Using stories to support problem solving. Educational Technology Research and Development, 50(2), 65-77.

Jonassen, D. H., Tessmer, M., & Hannum, W.H. (1999). Task analysis methods for instructional design. Mahwah, N.J.: Erlbaum Associates.

Klenowski, V. (2002). Developing portfolios for learning and assessment: Processes and principles. London: Routledge Falmer.

Kolodner, J.L. (1993). Case-based reasoning. New York: Morgan Kaufman.

Kolodner J.L., & Leake, D.B. (1996). A tutorial introduction to case-based reasoning indexing evaluations of buildings to aid conceptual design. In D.B. Leake (Ed.), Case-based reasoning: Experiences, lessons, and future directions pp. 31-66. Menlo Park, California: AAAI Press.

Kozma, R.B., & Anderson R.E. (2002). Qualitative case studies of innovative pedagogical practices using ICT. Journal of Computer Assisted learning, 18, 387-394.

Lindner, R.W., & Harris, B. (1992). Self-regulated learning in college students: Its assessment and lessons learned. Paper presented at the Annual Meeting of the American Educational Research Association (Atlanta).

Mack, R.L., & Nielsen, J. (1994). Executive summary. In J. Nielsen, & R.L. Mack (Eds.), Usability inspection methods pp. 1-23. New York: John Wiley & Sons.

Meltzer, J., & Sherman, T.M. (1997). Ten commandments for successful technology implementation and staff development. NASSP Bulletin, 81(585), 23-32.

Meredyth, D., Russell, N. Blackwood, L., Thomas, J., & Wise, P. (1999). Real time: Computers, change and schooling. Brisbane: Department of Education, Training and Youth Affairs.

Mize, C.D., & Gibbons, A. (2000). More than inventory: Effective integration of instructional technology to support student learning in K-12 schools. Paper presented at the Society for Information Technology in Education International Conference (11th, San Diego, CA, February 8-12).

Nielsen, J. (1994). Heuristic evaluation. In J. Nielsen, & R.L. Mack (Eds.), Usability inspection methods pp. 25-61. New York: John Wiley & Sons.

Otto, T.L. (2003). Principals' beliefs about teaching with information and communication technologies. University of Southern Queensland. An unpublished dissertation.

Phillips, R. (2001). Learning-centred evaluation of computer-facilitated learning projects in higher education. Perth, Western Australia: Committee for University Teaching and Staff Development.

Pintrich, P.R., Smith, D.A., Garcia, T., & McKeachie, W.J. (1991). A manual for the use of the Motivated Strategies for Learning Questionnaire (MSLQ). Ann Arbor: University of Michigan.

Queensland Government (2002). Queensland the smart state: Education and training reforms for the future. Brisbane: The State of Queensland, Department of the Premier and Cabinet.

Queensland Government (2003). ICTs for learning: ICT Innovastors Grants for Schools. available http://education.qld.gov.au/itt/learning/html/ictinnovation.html

Riessman, C.K. (2002). Analysis of personal narratives. In J.F. Gubrium, & J.A. Holstein (Eds.), Handbook of interview research: Context and method (pp. 695-707). Thousand Oaks: Sage.

Roblyer, M.D. (1993). Why use technology in teaching? Making a case beyond research results. Florida Technology in Education Quarterly, 5(4), 7-13.

Schank, R.C. (1996). Goal-based scenarios: Case-based reasoning meets learning by doing. In D. Leake (Ed.), Case-based reasoning: Experiences, lessons and other future directions pp. 295-347. Menlo Park, California: AAAI Press.

Spiro, R.J., Feltovich, P.J., Jacobson, M.J., & Coulson, R.L. (1992). Cognitive flexibility, constructivism, and hypertext: Random access instruction for advanced knowledge acquisition in ill-structured domains. In T. Duffy, & D. Jonassen (Eds.), Constructivism and the technology of instruction: A conversation pp. 57-75. Hillsdale, N.J.: Lawrence Erlbaum.

Wiedmer, T.L. (1998). Digital portfolios. Phi Delta Kappan, 79(8), 586-589.

Appendix A: Sources of New Information to Confront Principals' Beliefs about Teaching with ICTs

Barriers to Principals Developing New Beliefs about Teaching with ICTs

1. Dilemma of old and new worlds co-existing and need to balance print based and ICT based pedagogy;
2. Focus on building ICT infrastructure and attending to management issues rather than pedagogy;
3. Demands of school management issues;
4. Introduction to ICTs late in life and personal interest in ICTs limited to tasks at work;
5. Limitations in vision of teaching with ICTs, knowledge of educational software, and pedagogical knowledge;
6. Paucity of exemplars of teaching with ICTs;
7. View of knowledge as static and limited understanding about the management of knowledge with ICTs; and
8. Beliefs about teaching e.g., children choices, focus on teaching basic knowledge.

Existing Sources of Information that Influence Beliefs about Teaching with ICTs

Enacting

1. Past experience as a teacher; and
2. Fragmented teaching experiences while releasing teachers for non-contact time, taking classes for absent teachers, and meeting teacher requests for assistance.

Observing

1. Sporadic observations of effective and ineffective teachers in own school based on personal understanding and beliefs about the principles of effective teaching.

Being Persuaded

1. Education Qld mandates and policy;
2. Few opportunities and limited interest in Professional Development;
3. School Opinion Survey; and
4. Professional conversation with teachers and discussions with parents and community.

Affective State

1. Perceived needs of children, including own children; and
2. Limited confidence and experience in teaching with ICTs, using ICTs, and using educational software.

Existing Beliefs about Teaching with ICTs

NEW BELIEFS CONFRONT EXISTING BELIEFS

New Stories To Share With Teachers in Professional Conversation

New Beliefs about Teaching with ICTs

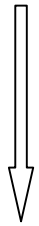
Enacting

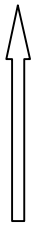
1. At own school, co-operatively plan and teach a unit of work that makes use of ICTs;
2. Participate in an electronic learning project at an Education Qld Centre of Excellence;
3. Trial educational software to become familiar with objectives and content; and
4. Seek and engage in professional development opportunities e.g., the Caring Intellectual Leadership Model (Rettig et al., 2000).

Observing

1. Observe teaching with ICTs in own and other schools;
2. Visit work places and tertiary institutions to observe use of ICTs and discuss expectations of school graduates;
3. Visit high schools to observe use of ICTs and discuss expectations of children leaving year 7;
4. Visit model schools e.g., Teacher Development Centre, Woodcrest College; and
5. Actively seek exemplars e.g., videos of practices, journal articles, The Learning Place and other web sites.

EXISTING PROCESSES





NEW PROCESSES

Being Persuaded

1. Read and reflect on the requirements, purpose and implications of Education Qld mandated policy;
2. Collaborate and network with peers to share stories;
3. Engage in processes to promote congruency between beliefs, principles, and practices (Atkin, 1996);
4. Engage in processes to challenge beliefs (Carlson, 1994);
5. Seek opportunities to identify and reflect on one's beliefs; and
6. Compare exemplars e.g., videos, continua of effective teaching with ICTS, with own beliefs and practices.

Affective State

1. Become comfortable in using ICTs by seeking support from competent staff, private providers and courses, own children, experimentation and play, and troubleshooting;
2. Share stories of successes and challenges with other principals;
3. Take small steps in order to make the larger gains;
4. Aim to go beyond concerns about management issues and resources to create new uses for existing ICTs; and
5. Seek to verify personal beliefs about what is in the interests of children.

New Sources of Information that Influence Beliefs about Teaching with ICTs

1. Environment for change supported by State and National Government policy;
2. Education Qld initiatives and mandated policy including an Integrated Outcomes Based Curriculum Framework, new syllabi e.g., focus on lifelong learning, Literate Futures Project, Management and Learning Technology Plans, Minimum Standards for Teachers: Learning Technology, and Information and Communications Technology Continua; and
3. Concern for the needs and interests of children and the development of responsible and successful citizens.

Conditions that Favour Principals Developing new Beliefs about Teaching with ICTs

Source: Otto (2003)

Appendix B: Evaluation Framework

Phase/Focus	Purpose	Evidence	Methods
1. Design			
1.1 Curriculum analysis	To describe the inadequacies of current principals' learning, with particular attention to the shortfall in learning opportunities	Analysis of the nature and extent of the shortfall in principals' learning and the probable reasons for it	self, peer & expert review
1.2 Teaching-for-learning analysis	To describe and justify the teaching, learning, and assessment process likely to bring about the desired learning outcomes	Description of the proposed teaching and learning process with argument indicating why it is likely to redress the shortfall in learning outcome	literature review
1.3 Specification of innovation	To describe and justify the proposed implementation, and indicate how it will facilitate the desired learning process and outcome	Educational plausibility is established by detailing implementation within the context, and specifying how the learning process and outcome will be assessed	prototyping, storyboarding peer & expert review of anticipated costs and institutional "fit"
2. Development			
2.1 Formative monitoring of learning environment	To determine whether the innovation is functional in its context and accessible and attractive to principals	Evidence focussed on the workability of the innovation and principals' involvement with it	observation, video, user tracking, principals reactions viability and modifications through peer and expert review (including self-regulation self-reporting inventory and usability inspection method)
2.2 Formative monitoring of learning process	To determine whether the innovation is influencing the learning process as intended	Evidence focussed on the nature of the learning process and its immediate consequences	video, think aloud, stimulated recall, teach-back, reflective journals viability and modifications through peer and expert review
3. Implementation			

3.1 Summative evaluation of learning outcome	To determine whether the learning process is as intended	Evidence focussed on the nature of the learning outcome	outcome-relevant assessment tasks interviews with participants
3.2 Summative evaluation of innovation validity	To determine whether the innovation is educationally appropriate in its immediate context	Evidence of the educational worth and viability of the project for the purposes concerned and integration of the project into practices	peer and expert review based on evidence in 2.1, 2.2, & 3.1
4. Institutionalisation			
4.1 Impact evaluation	To determine the robustness of the learning and its transfer beyond the immediate context of the innovation	Evidence of beneficial effects on understanding and learning in related areas	indirect indicators (e.g. progress and retention rates) development of generic capabilities transfer to practice
4.2 Maintenance evaluation	To determine the sustainability of the innovation in the context	Evidence of the educational benefits of the innovation considered in relation to its maintenance costs and educational and funding policies of Education Queensland	peer and expert review

Source: Bain (1999)