USE OF PROBLEM-BASED LEARNING FOR IN-SERVICE TEACHER TRAINING IN COMPUTER INTEGRATION IN THE CLASSROOM

by

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ABSTRACT

The purpose of this case study was to understand and describe teachers' responses to the use of problem-based learning as a model for in-service professional development in computer technology integration. Seven urban high school teachers from different disciplines used 8 release days over a 3 1/2-month period to work collaboratively to address an ill-structured problem. Data was gathered from interviews, self-administered questionnaires, on-line discussions, observations and teachers' own reflective writings.

A problem-based learning model can provide positive professional development experiences for teachers in technology integration. Teachers in this study valued and benefited from the learning opportunities this model provided particularly the support over time, purposeful work, group collaboration, and time for discussion and reflection. However, for PBL to be a more effective model for teacher professional development in technology integration, it may need to be adapted to meet the specific needs of teachers and the context in which they work.

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CHAPTER ONE

INTRODUCTION

Background

Six years ago, a principal at my school told teachers to submit student marks on computer discs using a software program called Remark. We were given no choice. While I welcomed the challenge of learning something new, I worried over my complete inexperience with computers and the amount of time it would take to do a task that I could normally complete within a day. With a simplified manual, I sat down in front of the computer, and gingerly hit the keys. After much trial and error, I did get my marks on the disc; but more importantly, I was struck by the power of the computer and the possibilities it offered to a learning environment.

I decided soon after to buy my own computer and enrolled in a night course in Beginners DOS. I took every professional development workshop possible that had anything remotely to do with computers. A year later, I enrolled part-time in a university diploma program in Computers in Education. I had much initial self-doubt since I was a woman approaching forty years of age and an English teacher with very little knowledge of or experience with this technology.

As I became more computer literate, I also became acutely aware that something was missing. In my courses, few people were talking about ways to actually integrate the technology into the teaching-learning process that went beyond computer skills acquisition. My enthusiasm and energy and passion for learning about this technology were still strong, but I knew there was still much more to learn. I wished that there were

more time and opportunities to work with other teachers in my school, with whom I could discuss, inquire, learn from and share information and ideas about technology integration.

It was about this time that our school became networked and equipped with a multipurpose lab of 30 computers with access to the Internet. I didn't know exactly how, but I intuitively knew that networked computer technology was the educational tool I had been looking for.

After fifteen years of teaching, no matter how hard I tried to give students greater freedom for personal construction of knowledge and make self-directed learning a workable option in a classroom setting, my efforts were always hindered. I had limited classroom resources and I was entrenched in a system that was based predominately in a knowledge transmission approach to instruction and student evaluation. I believe that if we are to give students more freedom to control their learning environment and allow students to go as far as they want to with their questions or topics of study, we need to provide them with greater access to learning resources. Typically in a high school, access to resources such as the library is not only constrained by the school timetable, but also is usually shared by as many as 80 to 100 teachers.

By this time, I decided to pursue graduate work and was granted a paid one-year leave to begin my course work. I was thrilled at having the opportunity to focus fully on my learning goals particularly on how to fit the technology into the teaching-learning process. As a result of much study, reflection and dialogue with other graduate students, academics and other professionals whom I have encountered over the past year, I have learned that technology can never replace good teaching (Bates, 1995; Bourdeau & Bates, 1996; Laurillard, 1993). I have learned that student-centered learning and socially

mediated knowledge construction shift the teaching-learning paradigm to a more constructivist one and that networked technologies can provide sustainable and manageable conditions for contructivist teaching and learning (Abrami & Bures, 1996; Harasim, 1990; Jonassen, Davidson, Collins, Campbell, & Haag, 1995; McDonald & Gibson, 1998; Wilson, 1996). I have also learned that teachers need a lot of support, not just in technology skills acquisition, but in understanding the role of technology in the teaching-learning process. Teachers need opportunities where they can ask questions, express concerns, discuss, challenge, reflect and learn from and with others.

Last year, administrators at my home school created a teacher leader position as Technology Resource Teacher and they offered the position to me. Although I was also teaching full time, my main duty in this position was to help interested staff begin the journey towards successful integration of networked technology into the classroom. Because I was so passionate and determined to learn about this technology, I was willing to invest much personal time and money in order to learn how to use this technology in my classroom, but I knew that I could not assume that other teachers would be as motivated.

I am no expert but what I have experienced these past four years, however, is a kind of transformative process that has changed my attitude towards, understanding of and approach to teaching with computer technologies. This process I now realize was founded not on expert advice or theories of educational practice but on my personal engagement with and active reflective inquiry into computer technologies in the classroom. In other words, how I came to understand the use of networked technologies in the classroom was through a process not unlike a problem-based learning approach.

This approach includes an understanding of one's learning needs, application of one's knowledge to problem situations, collaboration and reflection (Hmelo & Evensen, 2000). Can such an approach or process for teachers be established within a school setting? This was the challenge I saw before me.

Teacher Training in Technology Use in the Classroom

Generally, problems in applying information technologies in professional practice have been interpreted as problems in learning how to use equipment and software. However, newer training models are beginning to address the issue of providing alternative approaches to in-service training for teachers for implementation of computing in school settings (Gilmore, 1995; Kopp & Ferguson, 1996; O'Donnell, 1996; Pellegrino & Altman, 1997; Wang, 2000; Yocam, 1997). Pellegrino and Altman describe a model of teacher training that involves three phases: familiarization, utilization and integration of technology. The integration phase involves modeling effective and innovative teaching with technology. Other characteristics of newer training models include emphasis on the teaching and learning process rather than the technology itself, on teacher participation in the planning process, and locating the training at the school site to enable greater collaboration (Gilmore, 1995; O'Donnell, 1996). This emphasis on providing teachers with on-site opportunities to dialogue amongst their peers about the role of technology in their own practices may be one of the more important factors in effective integration of computers in the classroom. Certainly for me, it was a critical ingredient in my training in understanding and utilizing these technologies in my own classroom.

Effective use of computer technology in classrooms involves understanding what meaningful learning is and how different learning tools can contribute to meaningful learning experiences for students. Jonassen, Peck, and Wilson (1999) argue that meaningful learning is active, constructive (learners integrate new experiences with prior knowledge and construct their own mental models to explain what they are learning), intentional (learners reflect upon and regulate their own learning experiences), and authentic (learning tasks are situated in real-world or case-based learning environment). Jonassen (2000) further postulates that the educational usefulness of computer tools lies in how well they are used as cognitive tools or tools for thinking. He argues that " the most effective uses of computers in classrooms are for accessing information and interpreting, organizing and representing personal knowledge" (p. 4).

Although, the literature offers many approaches describing how teachers can learn to effectively incorporate technology into their classrooms, one approach to learning in general that I found especially intriguing was problem-based learning. PBL has been used extensively in the medical profession, but less so in education until just recently. Problem-based learning has been described as a basic human learning process founded in patterns of reasoning that allowed humans to survive (Glasgow, 1997). Problem-based learning begins with some problem and these problem- centered environments can provide the impetus for meaningful learning where learners come to understand their knowledge needs and apply new knowledge constructed through cognitive and social interactions (Hmelo & Evensen, 2000).

Within education, a problem-based learning model for training teachers in curricular reform seems to be an effective and useful change agent (Manning et al., 1994). Research

studies on the use of problem-based learning have been conducted in the training of school administrators and teachers in specific content areas (Bridges, 1992; Williams & Williams, 1994). Some educators have noted that effective faculty development practices utilize the same features of problem-based learning, such as:

- Teachers work together to solve real problems.
- Teachers direct their own learning.
- There are opportunities for teachers to collaborate in teaching one another.
- Previous experience is explored in the process of learning.
- The leader is a coach, observing and giving feedback.

(Wilkerson & Hundert, 1991, p. 168)

However, there appears to be little written on the use of problem-based learning and teacher professional development in computer integration in the classroom. This study was designed to address this gap in the literature by focusing on teachers' experiences with problem-based learning as a model for in-service teacher training in technology integration.

Research Questions

Overview and Statement of the Question

The general purpose of this study was to examine the use and possibilities problem-based learning offered as a context for participants to learn about and teach with networked technologies. How teachers responded to learning about networked technologies and their use in the classroom using a problem-based learning approach was the primary focus of my study. Participants in this study were given the following problem:

> The Internet has arrived in your classroom! You are feeling the pressure from administrators, parents and students to use this technology in your classroom. You would like to learn more about how to use the Internet for teaching and learning but you are not sure how to go about it. Your department teacher leader has asked you to prepare a brief oral report on some issue related to teaching with technology and create a web site with activities for students in your classroom.

I guided the participants through the problem-based learning process by facilitating discussion and promoting participant and group self-directed learning. This is akin to the role of the facilitator in problem-based learning, which is to help learners help themselves in the learning process (Barrows & Tamblyn, 1980).

The participants engaged in self-administered pre- and post-questionnaires, taped interviews with myself, and written records of their personal accounts of their experiences in this project. These accounts included participants' observations, feelings, reactions, interpretations, reflections, or ideas about problem-based learning, teacher training in integration of computer technologies, and teaching and learning with networked computers. Teachers also used online conferencing software to dialogue, collaborate, find shared meanings, and reflect on their experiences and insights while participating in this project. I moderated the online discussions using software from an on-line company called Blackboard. The software was available free of charge on the Internet.

Research Questions

The study was guided by the following questions:

1. Will teachers find the PBL experience a satisfactory approach to learning about and with technology?
2. Will using a PBL model address the varying needs and levels of technical expertise of teachers?
3. What conditions and resources do teachers find necessary for integration of technology in the teaching-learning process?
4. Will using this model have any effect on teachers' instructional beliefs and confidence in implementing technology in the classroom?

Importance of the Study

This study is important because it addresses (a) the concern from teachers, school administrators, and educational researchers for more effective teacher training in the educational application of learning technologies; (b) the need for new approaches to teaching and learning that exploit the features of new technologies (Bates, 1995); and (c) the fact that there is little research on training in-service teachers in learning technologies using a problem-based learning model.

Need for Effective Teacher Technology Training

Schools across North America are being equipped with computers and networked technologies yet minimal attention is being given to staff training in learning how to make pedagogical use of these technologies. The Ministry of Education in British Columbia for example, has committed $179 million dollars from 1995 to 2004 to equip public schools with hardware and software in order to develop an infrastructure to support information communications technology use in schools. Yet only $11 million from 1995 to 2000 has been spent on teacher training (BC Ministry of Education,

Technology Plan 2000). In a recent New York Times article, it was reported that although 95% of American schools have Internet access, 61% of teachers consider themselves somewhat prepared or not at all prepared to integrate the technology into their classrooms (Harmon, 2000). In a report released in 1999 titled, Computer Use in Schools, Statistics Canada noted that one of the biggest obstacles to greater computer use in schools was lack of training opportunities for teachers.

There are a number of relatively recent federally and provincially commissioned reports all recommending that funding for staff training be increased and that staff training focus on the application of learning technologies in the classroom and not just on computer skills acquisition. In 1995, the Canadian Alliance of Education and Training Organizations prepared a report titled, Professional Development and Learning Technologies and recommended that organizations:

1. Provide time for and access to discipline and profession-based professional development opportunities delivered using the technologies.
2. Provide ongoing programs of support for educators and trainers, and technology renewal /updating.
3. Incorporate dialogue and debate on the values, nature and objectives of the teaching/learning process and the role(s) of learning technologies. (p. 114)

Furthermore, a British Columbia Ministry of Education task force comprised of members of the British Columbia Teachers' Federation and ministry officials, completed a report, Information Technology in Education Plan for 2000 and Beyond, and identified a goal that educators be trained to effectively integrate information technologies into teaching practices (B.C. Ministry of Education, 1997).

Yet all these documents mention little of how to more effectively train teachers in the use and application of information technologies in the learning process. This gap in knowledge of effective training strategies for teachers has left some districts developing professional development activities resembling what Bates (1995) describes as, "the frenetic activities of the White Rabbit in Alice in Wonderland; because it does not seem to know where it is going, any road will do" (p. 230).

Other districts like the Vancouver School District try to keep up with new knowledge of effective teacher professional development and have shifted their approach to technology training for teachers from district wide professional development workshops on how to use computers to school based professional development initiatives (Vancouver School Board, 1998). Plans for the 2001-2002 school year include self-directed technology teacher mentoring programs for teachers of grades six to nine.

Need for New Approaches to Teaching and Learning of New Technologies

The Office of Learning Technologies, Human Development Canada funded a project began in 1997 and looked at the integration of computers into the secondary curriculum. Included were recommendations for more administrative and technical support to be given to teachers as well as a non-conventional training model, such as action research to introduce technology to staff. The report recommended that school districts:

> offer meaningful and creative experiences; help teachers believe they can do it; develop collaborative models and confidence; provide modeling and mentoring; and foster dialogue on the purpose of teaching and the roles of learning technologies in teaching.... Teachers need to be taught in new ways, using new technologies (Canadian Alliance of Education, 1999, p. 32).

The barrier to effective use of technology in the classroom according to Bates (1995) is, "the lack of an appropriate conceptual framework to guide the use of technology" (p. 245). In other words, teachers need adequate training not just on how to use the new technologies but on educational theory and practice that optimize the instructional qualities of those new technologies.

My study looked at teachers' experiences with problem-based learning as an instructional framework on which to train teachers in technology integration. The use of problem-based learning also modeled for teachers an approach to integrate computer technologies into their own classrooms. In other words, this approach to staff training in technology use and computer integration was chosen to provide teachers with first hand experience of PBL as they constructed new knowledge and to model for teachers a classroom strategy for integration of learning technologies that shifts the learning process to a more student-centered one. The shift from teacher as expert in a teacher-centered classroom to facilitator in a student-centered classroom may be necessary for effective integration of new technologies (Bates, 1995; Leu & Kinzer, 2000).

Lack of Research in Problem-based Learning and Teacher Technology Training

The development and applications of problem-based learning in educational settings have been traced to health science curricula in North America in the 1960s and 1970s as a way to prepare medical professionals to deal with uncertainty, ambiguity and rapid changes and growth in medical knowledge (Barrows & Tamblyn, 1980; Boud & Feletti, 1991; Engel, 1991). Problem-based learning has been implemented in various curricula such as law, engineering, social work, and architecture since the 1960s and there exists a

large body of research on teaching and learning within PBL, learner assessment, and evaluations of the impact of PBL (Williams & Williams, 1994).

While there is much research on the effective use of medical models of problem-based learning and its effects on learning, there appears to be little written on the use of problem-based learning and teacher professional development in computer integration in the classroom. My study of the experiences of teachers as they learned about technology integration within this framework may begin to fill in this apparent gap in the literature. Data collected from the participants and myself in this study may offer teacher professional development organisations useful knowledge on the use of PBL as a training model and identify issues that may need to be addressed before teachers feel comfortable adopting new technologies into classroom practices.

CHAPTER TWO

LITERATURE REVIEW

The general purpose of my study was to examine the use of a problem-based learning model as a context for teachers to learn about and teach with networked technologies. Specifically, I wanted to find out what experience teachers would have and whether this model would have any effect on teachers' instructional beliefs and confidence in implementing technology in the classroom.

In order to address these questions, I reviewed two contributing areas of the literature, namely problem-based learning and teacher professional development in technology integration. In order to understand the important thinking and research on problem-based learning, I examined the literature on the critical features of this model, namely the use of an ill-structured problem, collaborative learning and the role of the facilitator. I also reviewed some evaluation studies of the effectiveness of problem-based learning in professional settings.

In my study, teachers engaged in online asynchronous computer mediated collaboration. Therefore, I also examined some of the literature related to online collaboration in order to provide a framework for understanding this aspect of my study.

The third section of my review looks at other research on teacher professional development, particularly in technology integration, and concludes with an examination of effective teacher professional development in technology integration as described in the literature.

Problem-Based Learning

Definition and Overview

Problem-based learning (PBL) is an approach to learning "that results from the process of working toward the understanding or resolution of a problem" (Barrows & Tamblyn, 1980, p. 1). The problem-based learning cycle begins with some problem that group members discuss, define, generate additional questions, and formulate some action plan that offers some solution to the problem (Hmelo & Evensen, 2000). It is an iterative process that begins before any instruction; once the problem has been presented, learners apply problem solving skills such as identifying key features of the problem and determining how to approach, manage, and search for information about the problem (Barrows & Tamblyn, 1980). Learners can engage in a variety of learning activities either independently or collaboratively in order to construct a deeper understanding of the problem that may lead to some solution or product (Woodward, 1997).

According to one educator, PBL is fundamentally different from subject-based learning in that expertise is not equated with content knowledge but rather is an ability to make judgments, identify problems, and know how to go about solving them (Margetson, 1997). Margetson adds that content is not acquired in the abstract or memorized but rather learned as needed and put to some use. Problem-based learning he notes, encourages reflective, critical, and active learning; it is a shared educational process for both teacher and learner and reflects an epistemology that knowledge construction is dynamic, personal and is the result of shared responses to problems learners perceive in their world.

In their studies on problem centered collaborative knowledge building, Bereiter and Scardamali (2000) found that when students are freed from the expectation of finding final answers, "they ask what we call knowledge-based questions, questions that arise from their own puzzlement or perceived lack of understanding. These are questions that teachers and independent raters judge to be of greater educational potential than text-based questions" (p. 188).

Problem-based learning is also different from case based learning. In typical case based learning, the facts to be explained are all given to the learner (Bereiter & Scardamalia, 2000). According to Savery and Duffy (1995), case based learning is used as a means to test learner's understanding; the case is presented after the topic has been covered. They add that in problem-based learning all the learning springs from considering the problem itself.

Origin of Problem-Based Learning

Problem-based learning as a teaching-learning model originated and has been well documented in medical education (Bereiter & Scardamalia, 2000; Hendry & Murphy, 1995; Schmidt, 1995). In fact, in much of the literature, the origins and development of the medical model of problem-based learning have been attributed to Dr. Howard Barrows who first implemented this approach at McMaster University in Canada in the mid 60s (Bridges, 1992; Delisle, 1997; Hendry & Murphy, 1995; Hmelo & Evensen, 2000; Torp, & Sage, 1998).

Barrows sought to help doctors construct useful knowledge, develop reasoning strategies, increase motivation for learning and become effective collaborators (Barrows, 1986). Barrows' mode has two main features: learning is student-centered and driven by a

rich problem (Hmelo & Evensen, 2000). In this model, a group of students meet with a facilitator who provides students with limited information about a patient's case; students evaluate, define the problem, generate hypothesis, and research the related issues which they later share within their group (Barrows, 1986). Collaboration is necessary in PBL because the cognitive load and thinking required to solve the problem is more difficult for any one student to handle (Hmelo & Lin, 2000). The facilitator of a PBL group, according to Barrows (1988) is ideally a subject expert and a skilled tutor who monitors, guides, and supports the group learning process. PBL is now being used in more than 60 medical schools throughout the world and in many other professional and educational institutions (Delisle, 1997; Glasgow, 1997; Murray & Savin-Baden, 2000).

Educational Model of PBL

The use of PBL has spread beyond medical schools to various levels of learning in many different professions and academic disciplines (Hmelo & Evensen, 2000). These authors state:

> The wide dissemination of problem-based learning has spawned so many mutations that the genus "problem-based learning" now has an almost unclassifiable array of species. (p. viii)

However, Bereiter and Scardamalia (2000) describe several differences between educational and medical models of problem-based learning. According to their own studies in collaborative knowledge building within public school and graduate student groups, these researchers outline the following differences in problem-based learning as practiced in educational models:

1. The problems are usually at the level of principles rather than cases; for instance, "How does heat affect matter?" rather than "Why doesn't the ball go through the wing?"
2. The focus is on understanding rather than on reaching a conclusion or achieving a practical result.
3. Problems themselves are expected to undergo transformation in the course of inquiry, as they do in science. Thus it is not expected that problems will be solved but that the state of collective knowledge will be advanced.
4. The teacher functions as a co-investigator - more so than seems to be typical of tutors in [medical models of] PBL. (p. 187)

Torp & Sage (1998) argue that medical models of problem-based learning are supported by information -processing theory while educational models follow a more constructivist framework. They assert that medical models of problem-based learning have a direct relationship between learning situations and application situations; learners assume the role of doctors as they problem solve patients' needs or diagnosis because these learners will become doctors. Thus the learning situation:

- Activates prior knowledge, facilitating new knowledge.
- Parallels ways in which this knowledge will be needed in real-world situations.
- Increases the probability that the learner will recall and apply what is stored in memory. (p. 28)

However, in K-12 educational settings, educators must facilitate a wider range of cognitive activity:

> We, too, want our students to recall and apply what they have learned, but we cannot predict the setting in which this learning will be applied. Our students may go on to become teachers, engineers, secretaries, programmers, or? [sic] (p. 29)

This is echoed by other problem-based educators who have looked to constructivist pedagogical theory in order to realize learning opportunities that actively engage learners in knowledge seeking, problem solving, and collaborating activities (Hmelo & Evensen, 2000; Savery & Duffy, 1995).

The Problem in PBL

Problems in problem-based learning need to be realistic, complex, open-ended, and ill-structured in order to afford the learning opportunities for flexible knowledge construction and development of reflective reasoning strategies (Barrows, 1986; Hmelo & Evensen, 2000; Hmelo & Ferrari, 1997).

Ill-structured problems are messy, complex, and have no simple or fixed solution; not enough information is provided to solve the problem that can change as more information is gathered (Torp & Sage, 1998). Stepien and Pike (1997) give five characteristics of ill-structured problems; they:

- are not tidy, but messy when first encountered
- lack the needed information for being defined or resolved when first met by the problem solver
- require elaboration, organization, and analysis through inquiry
- are likely to change as more is learned about them through inquiry

- require decisions even if data are missing, or involves conflicting value positions that may be resolved through alternative solutions (p. 386)

Ill-structured problems promote the necessity for learner cooperation with others in order to effectively find some solution to the problem (Duch, 1999). Duch adds that a problem where students simply divide up the assignment, find the answers, and reassemble the information for some final submission usually results in students learning less not more.

The following is an example of an ill-structured problem that has been used in middle and high school classrooms. It is written in the form of a memo to a county manager:

> As you can see from the attached newspaper item, residents of Center County are under siege from a population of mosquitoes-possibly the largest ever. The usual mosquito control methods seem to be ineffective in reducing this unprecedented outbreak. Determine the cause of this outbreak and recommend appropriate solutions. I will expect to hear from you on the afternoon of July 17, 1997. In the meantime, I will contact the state to obtain the necessary additional funds to implement the best solution. (Torp & Sage, 1998, p. 37)

On the other hand, in a well-structured problem, all the important information needed to solve the problem is presented with the problem itself (Stepien & Gallagher, 1993). According to Stepien and Gallagher, problems that are well-structured can restrict opportunities for learners to examine numerous issues and develop skills of organizing and evaluating new information relevant to the problem. The benefits of using ill-structured over well-structured ones are the opportunities for student development of reasoning and metacognitive skills (Barrows& Tamblyn, 1980; Stepien & Pyke, 1997).

Schmidt and Moust (2000) assert that in order to determine the quality of a good problem, the context of a particular course along with the prior knowledge of students needs to be considered. This is because problems that activate prior knowledge through group discussion had a considerable effect on processing new information. In their research on quality of problems in problem-based learning, they found that the quality of the problem can affect the functioning of the group as well as time spent and interest in the subject matter. They also compared the influence of the tutor with the quality of the problem and concluded:

> Tutor performance only directly affects group functioning; all other influence is indirect, namely via group functioning. Problems, by contrast, influence almost all elements of the learning in a direct fashion. (p. 28)

Schmidt and Moust (2000) note that PBL literature contains very little on the role of problems and conclude that further study in what constitutes a good problem is needed.

Role of the Instructor in Problem-based Learning

Instructors or tutors of problem-based learning groups monitor the groups' progress, keep members on track and help students identify concepts they need to learn more about (Hmelo & Evenson, 2000). The PBL tutor "acts as a metacognitive coach who guides the development of higher order thinking skills by encouraging students to justify their thinking and to externalize self-reflection" (Hmelo & Ferri, 1997, p. 411). Silins and Murray-Harvey (1994) argue that PBL facilitators must adopt more student-centered learning principles:

> In PBL the case problem belongs to the students. The facilitator's role is not to solve the problem but to guide novice students to use effective problem solving strategies.

In this context, the facilitator must create a climate that encourages students to accept responsibility for their own learning. (p. 250)

This is echoed by Wilkerson and Hundert (1991) who assert that teachers who wish to move away from teacher centered learning to more student centered learning through a problem-based approach may need to redefine their role in the learning process. They add that teachers may also need to develop a greater awareness of their relationships to the content being learned, to the learning process, and to their students as self-directed learners.

A necessary condition for tutor effectiveness is his or her ability to understand and communicate with students at their level of knowledge; Schmidt and Moust (2000) identify this ability as cognitive congruence. They add that "both subject matter expertise and interpersonal qualities are necessary conditions for cognitive congruence to occur" (p. 43).

The Group Process in Problem- Based Learning

According to Hmelo and Evensen (2000), at the heart of problem-based learning is the group collaborative process. These authors contend that while there has been much research since the late 1980s on knowledge acquisition and benefits of PBL, little research has been done on group interactions in problem-based learning. There is, however, a body of literature on collaborative learning in other learning contexts (Bruffee, 1999).

Collaborative Learning

Collaborative learning has been defined as "any learning that takes place as a result of people working together," (Kaye, 1991, p. 2) but he adds that it is more than simple

information exchange. The following definition by S.R. Hiltz underscores the active role of the learner in a shared learning experience:

> Collaborative learning is defined as a learning process that emphasizes group or co-operative efforts among faculty and students, active participation and interaction on the part of both students and instructors, and knowledge that emerges from an active dialogue among those participants sharing their ideas and information. (as cited in Grundy, 1991, p. 168)

According to Johnson and Johnson (1975), "co-operative learning is the instructional use of small groups so that students work together to maximize their own and each other's learning" (p. 5). The terms *collaborative* and *co-operative* are sometimes used interchangeably in some of the literature (Jonassen, 1996; Kaye, 1991; Schwier, 1995). However, Bruffee (1999) posits that while the goals of co-operative and collaborative learning are similar, each was designed for "educating people of different ages, experience and levels of mastery of the craft of interdependence" (p. 86). He adds that in co-operative learning, teachers structure roles and ensure that all students contribute and are held accountable; students engaged in collaborative learning, on the other hand, govern themselves through group negotiation.

Slavin (1990) cites research, which he notes uses cognitive theories of learning to explain why co-operative learning promotes learner understanding and achievement. Cognitive learning theorists maintain that learning occurs when new information is *restructured* into the learner's existing knowledge structures, a process where the learner selects, organizes, links, and transforms information according to his or her own schema (Jonassen et al., 1995). Cognitive development can occur when learners interact in

collaborative learning environments where "group members exchange information and insights, discover weak points in each other's reasoning strategies, correct one another, and adjust their understandings on the basis of one another's understandings" (Johnson, Johnson & Holubec, 1994, p. 14). Resolution of cognitive conflicts is possible within collaborative learning environments as one can test one' s own understanding of oneself and others with other members of the group (Savery & Duffy, 1996).

As learners share differences in opinions and perspectives, a result for those learners can be "new knowledge, reorganised knowledge, or simply the awareness of a need for additional understanding" (Edelson, Pea, & Gomez, 1996, p. 152).

Research in face-to-face collaborative or co-operative learning suggests that there are benefits to learners working with other learners (Johnson & Johnson, 1975; Slavin, 1990). Citing and documenting numerous studies on achievement effects of co-operative learning, Slavin (l990) concludes that "under well-defined circumstances, co-operative learning can have consistent and important effects on the learning of all students" (p. 46). Similarly, Henri (1991) reports that collaborative work typically produces higher achievements than work done by individual members " due to the greater amount of information available within the group, the greater diversity of interpretations of fact and the opportunity to test individual ideas" (p. 120).

Theoretical Model of Factors Affecting Group Processes in PBL

One interesting model of group processes in problem-based learning was developed as a result of research by Schmidt and Gijselars (as cited in Schmidt & Moust, 2000) that aimed to uncover the factors that affected small group tutorial learning. Elements of the model below were treated as variables and measured in research studies conducted by

Schmidt and Gijselaers in 20 courses of Maastricht University medical curriculum in the Netherlands. This model identifies the variables affecting group processes and gives a causal representation of the paths within a problem-based learning context:

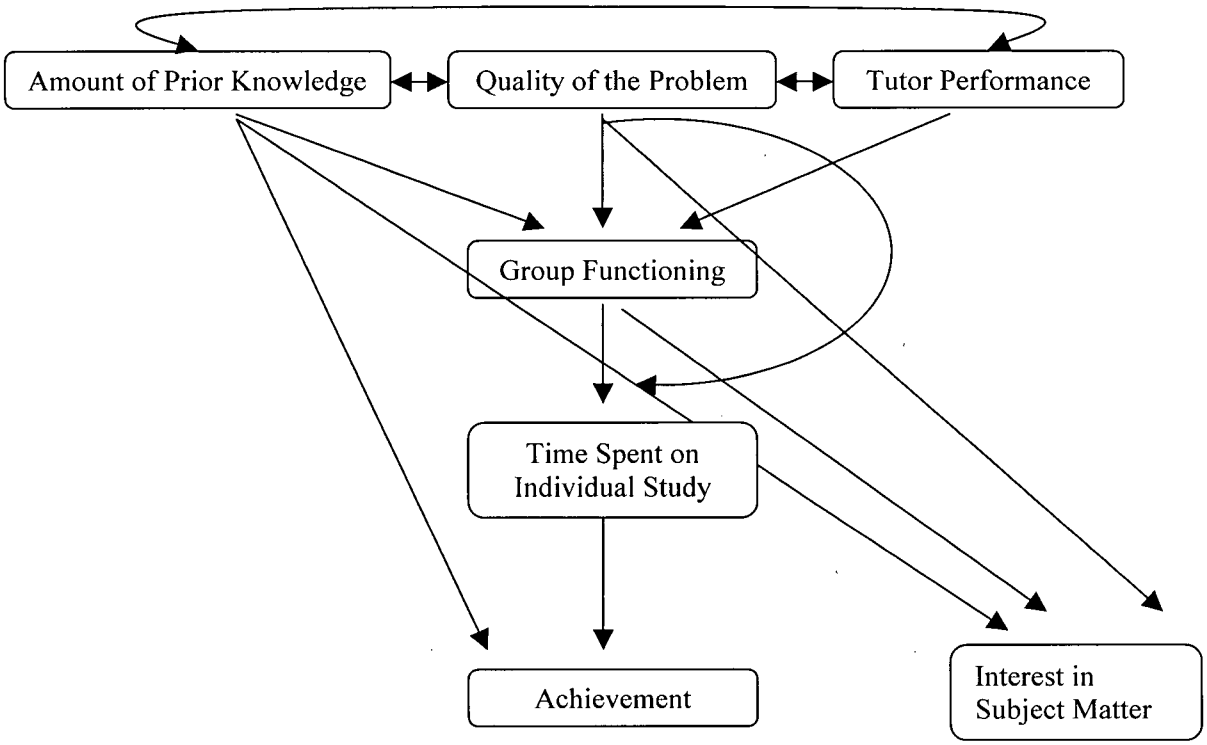

Figure 1: Causal paths for a model of PBL
(Schmidt & Moust, 2000, p. 29)

The findings according to these researchers imply that a poor problem can be an equally serious impediment to student learning as having a poor tutor and that improving the quality of a problem is bound to improve learning as is improving the performance of the tutor (Schmidt & Moust, 2000).

Benefits of Problem-based Learning

Barrows and Tamblyn (1980), although referring to a medical model of problem-based learning, identify two advantages of this student-centered learning approach. They are the development of problem solving skills and knowledge acquisition of learners:

> Information, concepts, and skills learned by the student are put into his [sic] memory in association with a problem. This allows the information to be recalled more easily when he faces another problem in which the information is relevant ... He must get information, look for cues, analyze and synthesize the data available, develop hypotheses, and apply strong deductive reasoning to the problem at hand. (p. 13)

Bridges (1992) posits that a rationale for using PBL rests on cognitive, motivational, and functional grounds. He cites studies that show students generally retain little when taught using a lecture method and that PBL, on the other hand, creates conditions that optimize understanding, processing, and recall of information. Students' prior knowledge is activated as they apply what they already know about the problem and acquire new knowledge in a functional context, which will assist the learner in remembering (Bridges, 1992). Learning content knowledge may take longer through PBL but, "the trade-off is that students learn conceptual knowledge more deeply along with important metacognitive skills needed for lifelong learning" (Hmelo & Ferrari, 1997, p. 416).

Research on student affective outcomes indicates some very conclusive results. In one study, students "reported that they studied harder, enjoyed it more, and learned more" (Woods, 1991). Bridges (1992) reports that students in PBL programs have more positive attitudes toward their studies than students in more traditional programs. Ryan (1997) describes a study, which used both quantitative and qualitative research methods to look

at the experiences of 120 medical in a PBL program. This study reports evidence of increased motivation but suggests other course-related factors such as availability of resources, time to explore issues and student workloads can undermine positive outcomes with PBL.

Role of Technology in Collaborative Learning

A growing body of literature describes the developments in online technology and its ability to support constructivist approaches to teaching and learning (Abrami & Bures, 1996; Harasim, 1990; Harasim, Hiltz, Teles, & Turoff, 1997; Jonassen et al., 1995; Reil, 1990, Wilson, 1996). Some educators also claim that this is particularly in the ability of the technology to support conversation and collaboration (Jonassen et al., 1995; Murphy et al., 1996). Some researchers claim that these communication technologies, which link learners, can support collaboration (Savery & Duffy, 1996) and can also increase levels of communication and co-operation (Hiltz, 1990).

Computer conferencing software provides a group space for shared discussion where messages are organized and stored sequentially, but unlike bulletin board systems, support a greater range of learning activities (Harasim et al., 1997).

Asynchronous computer conferencing involves two-way communication that is predominately text dependent information exchange or communication among groups of participants independent of time and place. The technology is relatively new and therefore there is little, " developmental history upon which to base quality assessment" (Gunawardena & Lowe, 1997). There is, however, a growing body of literature that looks at the distinguishing features of computer mediated conferencing and examines their effect on online group interactions and learning (Bullen, 1997).

While there seems to be some agreement among some researchers on the interactive and collaborative capabilities of computer conferencing, the nature of asynchronous text-based collaboration can be very different from face-to-face collaboration and "produce social environments different from traditional classrooms, impacting interactions and group dynamics" (McDonald & Gibson, 1998, p. 7).

Text-based Collaboration

One of the distinguishing features of asynchronous group collaboration is the use of text as the sole means of group communication (Harasim, 1990). This might change as bandwidth increases to provide quality video and audio. At present, though, text-based communication is the primary mode of online interaction and this has positive and negative effects on group collaboration (Abrami & Bures, 1996; Harasim, 1990).

On the positive side, researchers have reported on the *democratizing effect* of text-based online interaction (Harasim, 1990; Romiszowski & Ravitz, 1997). Bates (1995) maintains that participation in online group activities is "is judged solely on the value of their [students] written contributions" (p. 209) and students are freed from face-to-face barriers of participation such as powers of public oratory, interruption, shyness and member dominance (Harasim et al., 1997). The results of one comparative study to see if the absence of social cues of group members' status made online discussions more egalitarian than face-to-face discussion of members with mixed status indicated that on-line high status members had reduced influence and proportion of talk (Kiesler, 1991). Similarly, Harasim reports on Rice's research study that suggests that "more reserved group members may finally gain access to discussions and decision-making, while any individual may have a harder time gaining the group's attention" (as cited in Harasim, 1990, p. 47). In

fact, claims Hiltz (1994), "There are no limitations (in a virtual classroom)... on the ability to form a collaborative learning community that includes a diversity of people: different ages, different life experiences to share, from any part of the world" (p. 29).

Furthermore, Bates (1995) reports that researchers have noted that text-based interaction in computer conferencing environment can enhance cognitive and metacognitive or cognitive awareness skills. Harasim (1990) suggests that "the need to verbalize all aspects of interaction within the text-based environment can enhance such metacognitive skills as self-reflection and revision in learning" (p. 49). She adds that participants in online courses report that they pay more attention to the content of a written message than an oral one. Computer conferencing tools that record and organize exchanges into threaded conversations that link discussion items provide more possibilities for reflective analysis and interaction (Kaye, 1991). Kaye writes:

> In the conventional seminar situation, if the right opportunity for a contribution is missed, it may be gone forever; subsequent review has to rely on partial recollections or selective note-taking, and continuation of the discussion and the re-investment of the results of analysis and reflection have to be postponed until the time of the next group meeting. Potentially, conferencing provides more opportunities for participation in group discussion and collaboration than face-to-face meetings, because it is not possible for turn-taking to be controlled in the same way, nor for dominant personalities to forcefully take over the discussion. (p. 17)

Time Independent Collaboration

In a time independent environment, there is less concern about time restrictions with which to respond to other learners and Harasim (1990) argues that this feature may serve the learning styles of group members who require more time to respond for reasons such as language deficiencies and shyness. However, group formation takes longer and co-ordinating tasks may be problematic in an asynchronous environment especially when group members have different expectations of how often and when to log on (Abrami & Bures, 1996).

One particular study looked at asynchronous group development patterns over three different time points in a graduate online course to see if there were any differences from face-to-face interpersonal group development. The results showed that online groups have "similar interpersonal issues, at comparable stages and proportions as reported in the literature of face-to-face groups" (McDonald & Gibson, 1998, p. 20). However, these researchers also acknowledged that more extensive research with more diverse groups is necessary in order to provide any conclusive generalisations about online group development.

Evaluation and Asynchronous Text Based Collaboration

Bullen (1998) reports that there is a lack of empirical studies that analyse the quality of computer conferencing interactions or which factors may affect online participation in collaborative activities. Furthermore, Mason (1991) points out that most evaluative research on computer conferencing based on quantitative analyses of number of postings and message chains, by whom and at what times and less on the actual content and value of the communication.

Mason (1991) contends that by breaking down collaborative processes "into examples of behaviour or written work which display these characteristics, it is possible to analyse conference content and draw conclusions about the educational value of the particular online activity" (p. 115). Accordingly, Henri (1991) has devised an analytical model that rates units of discourse based on their interactive, cognitive, and metacognitive elements. Interactivity according to this model is analysed in terms of explicit and implicit interactions and independent statements to evaluate whether online discussions are truly interactive or merely *collections of monologues*. An example of an explicit interaction would be a direct response or direct commentary and an implicit interaction would be responses that do not refer directly to another message. This model according to Henri may tell researchers how much interactivity occurs and where it is occurring which can both have implications on the online educational process.

Henri's model has been criticised for its linear analysis and for using a teacher centred paradigm which may not be appropriate for a constructivist learning environment where knowledge is shared construction and " does not necessarily progress through successive stages" (Kanuka & Anderson, 1998, p. 62). Gundawarda and Lowe (1997) also assert that Henri's interaction model is "mechanistic and descriptive, but not central to the construction of knowledge" (p. 407). Instead they propose a model of interaction analysis that considers processes involved in construction of knowledge and negotiation of meaning. In their study, interactions in an online debate were analysed in an attempt to find appropriate *interactional analysis techniques* with which to assess the quality of socially constructed knowledge. Their evaluation model was devised based on phases of social construction of knowledge. These include Phase 1: sharing/comparing of information;

Phase 2: discovery of dissonance and inconsistency; Phase 3: negotiation of meaning/co-construction of knowledge; Phase 4: testing and modification of proposed synthesis; and lastly, Phase 5: agreement/application of newly constructed meaning. This model of analysis of social construction of knowledge in computer conferencing is considered more appropriate than the system of analysis described by Henri (Gunawardena & Lowe, 1997).

Teacher Professional Development

Models of teacher staff development have traditionally been built on the notion that academic research and knowledge leads to improvement in teacher practice even though this notion more often than not has led to a failure in effective staff development (Eaker, Noblit, & Rogers, 1992; Fullan, 1995; Labaree, 1998; Richardson, 1994). Changes in educational practices have traditionally been mandated by those outside the classroom or external to the actual teaching place and the teacher is more often than not seen as a recipient, consumer, transmittee, and implementer of other people's programs and ideas (Cochran-Smith & Lytle, 1999; Richardson, 1994).

Schon (1987) describes professional practice as uncertain, unique and conflict-ridden zones of activity. He recognized that the ability of the professional to deal with these *indeterminate zones* comes not from learning how to apply research-based knowledge but rather from a process of inquiry of a situation in action that includes some reflection in and about that action. Like Schon, only 50 years earlier, Corey (1949) questioned the effectiveness of academic research and knowledge upon professional practice particularly with regard to the teaching profession. Although traditional research may have some impact on teacher practice, Corey asserted that teacher generated data, which the teacher interprets and applies to his or her own practice is more likely to have greater influence

on that practice. Labaree (1998) rightly acknowledges that the everyday experiences of teachers and students can often be very removed from academic educational theory making:

> In order to create a solid ground for making hard claims about education, you can try to drain the swamp of human action and political purpose that makes this institution what it is, but the result is a science of something other than education as it is experienced by teachers and students. (p. 9)

Fisher, Deshler and Schumaker (1999) assert that typical single professional development sessions with no opportunity for practice and feedback are less effective than more comprehensive programs. Comprehensive programs are those that are needs based, participant owned, and supported over time (Schumaker & Clark, 1990).

Such comprehensive models of teacher professional development where external expertise or direction is either absent or plays a secondary role are turning up in the literature (Huberman & Guskey, 1995). Furthermore, a growing body of research suggests when the need for improvement of practice is generated by teachers who define their own problems and actively participate in a process of systematic inquiry and reflection, the outcomes are more successful (Bridges, 1992; Eaker et al., 1992; Harris, 1993; Williams & Williams, 1994).

Teacher professional development practices in curricular reform that utilize the same features of problem-based learning appear to be more effective. They also address the needs of teachers as adult learners who are much more interested in practical and just-in-time relevance to their immediate needs and problems (Benor & Mahler, 1989 as cited in Wilkerson & Hundert, 1991; Cravener, 1998; Manning et al., 1994). Research on the use of

problem-based learning has been conducted in the training of school administrators and teachers in specific content areas (Bridges, 1992; Williams & Williams, 1994). Wilkerson and Hundert (1991) have identified features of problem-based learning in effective faculty development practices which include teachers working together to solve real problems and directing their own learning. In their work with science teachers, Marx, Blumenfeld, Krajcik, and Soloway (1997) have developed a framework of elements they consider necessary for professional teacher development. These elements are collaboration, enactment in classrooms, extended effort, and reflection. They point out "to build collegiality and to improve practice, teachers need to collaborate with peers as they reflect on what they do in class, how successful it has been and how to change it" (p. 354).

Teacher Professional Development and Technology Integration

Unfortunately, problems in applying information technologies in professional practices have often been interpreted as problems in learning how to use equipment and software (Marshall, 1993). This seems to be the case in teacher development programs in the use of computer technologies in the classroom (Gilmore, 1995; Pellegrino & Altman, 1997). Pellegrino and Altman cite conclusions made by the Office of Technology Assessment of the United States Congress:

> Most teachers have not had adequate training to prepare them to use technology effectively in teaching...Although schools have made significant progress in helping teachers to use basic technological tools as word processing and databases, they still struggle with integrating technology into the curriculum. (p. 91)

O'Donnell (1996) refers to Stasz and Shavelson (1988) who, "contend that the integration of computers with subject matter and classroom activities is the least well-addressed issue in staff development programs" (p. 25). As some educators have noted, improving teacher and classroom access to computer technology does not necessarily lead to integration (Bates, l995; O'Donnell). O'Donnell defines integration of computers as one that involves the teacher, the computer and the whole class in interactive learning. She adds that past in-service training has not taken into account the pedagogy of computer technology in the classroom.

In addition, according to O'Donnell (1996), past staff development programs have not addressed specific whole class instructional computer skills required by teachers in order to integrate this technology in their classrooms. O'Donnell writes:

> Teachers must acquire a wholistic view of computer integration in a whole class setting, with appropriate classroom techniques and student-centered strategies that lead to computer integration, not computer incorporation within the traditional classroom (p. 32).

Similarly, Schofield (1995) reports that many teachers in her study had difficulty envisioning how to integrate the one or two computers in their classrooms in their traditional whole class instruction methods.

According to some educators, the effective integration of technology into the classroom alters the teaching approach from a transmission model to a more constructive one (Bates, 1995; Jonassen et al., l995). One study describes how networked learning in the classroom promoted teachers' use of strategies that supported constructivist learning theory and "made it harder and harder to teach along traditional lines, with these new

resources" (McDonald & Ingvarson, 1997, p. 523). A growing body of literature describes the developments in networked technology and its ability to provide conditions for constructivist teaching and learning (Abrami & Bures, 1996; Harasim, 1990; Jonassen et al., 1995; Wilson, 1996). It may be useful then to consider exposing teachers to constructivist learning theory in training teachers in technology integration.

A study of a three-year program modeled a constructivist approach to teaching and learning and used a project-based learning experience for teacher-centered staff development in technology integration into the classroom (Yocam, 1997). Teachers were guided through activities, discussions, and reflections that concentrated on learning about knowledge construction and how technology might serve that process. A learning community developed and researchers in this study identified a series of stages that teachers went through: entry, adoption, adaptation, appropriation, and invention. Furthermore, an increasing number of studies suggests when the need for improvement of practice is generated by teachers who define their own problems and actively participate in a process of systematic inquiry and reflection, the outcomes are more successful (Bridges, 1992; Eaker et al., 1992; Harris, 1993; Williams & Williams, 1994).

Another study involved cluster meetings of groups of teachers who gave reports and shared experiences on their activities with computers (Gilmore, 1995). From these meetings, action plans for future training and use of computers in the classroom were developed. In this study, opportunities for teachers to be reflective and critical and control their learning experiences resulted in positive outcomes using and integrating technology in the curriculum. Hope (1996) also confirms that collaboration among

teachers where knowledge of computers is shared has a positive impact on teacher use of technology in schools.

Summary

Much literature has been written on problem-based learning, its strengths and weaknesses, effects on the teaching-learning process and applications to professional studies, especially in medicine. The literature review has revealed some of the salient features of problem-based learning, which helped me plan my research project and design the problem-based format used in this study.

This literature review on professional teacher development suggests that in order for professional development to be effective, it needs to be driven by teachers' needs and supported over time. The evidence presented on effective technology training for teachers purports that teachers need time to reflect on their practices, collaborate with other teacher users of technology, and be given opportunities to experience and consider constructivist learning environments. Can we merge problem-based learning with effective professional development practices to improve teacher use of technology in their classrooms? Evidence suggests it may well be worth trying.

CHAPTER THREE

METHODOLOGY

To examine teachers' experience with problem-based learning as a model for professional development in technology integration, I chose a case study research approach that involved mostly qualitative and some quantitative data collection and analysis. I chose this as my research approach due to the nature of the subject that I wished to examine, namely to understand and describe the experiences of a particular group of teachers in a particular setting.

Case Study

Generally speaking, the case study is a research design that aims to understand some particular phenomenon using a variety of data collection strategies (Hakim, 1987). What makes the case study different from other research approaches is not the methods used but the focus of the study itself (Merriam, 2001; Yin, 1994). The focus of a case study according to Merriam (2001) is necessarily on some *bounded* system:

> the single most defining characteristic of case study research lies in delimiting the object of study, the case ... If the phenomenon you are interested in studying cannot be intrinsically bounded, it is not a case (p. 27).

Similarly, Yin (1994) asserts that the focus of the case study is to investigate "a contemporary phenomenon within its real-life context especially when the boundaries between phenomenon and context are not clearly evident" (p. 13). He adds that a reason for using this approach is when the context is critical to the phenomenon of the study. Similarly, Stake (1995) asserts that the case study can be defined by its uniqueness; the

uniqueness is evident when the phenomenon that is being studied and its context cannot be easily separated.

Lawrence-Lightfoot (1997) defines context as "setting-physical, geographic, temporal, historical, cultural, aesthetic-within which the action takes place" (p. 41). She describes the importance of context within a phenomenological framework when she so eloquently writes:

> Context becomes the framework, the reference point, the map, the ecological sphere; it is used to place people and action in time and space and as a resource for understanding what they do. The context is rich in clues for interpreting the experience of the actors in the setting. We have no idea how to decipher or decode an action, a gesture, a conversation, or an exclamation unless we see it embedded in context (p. 41)

Case studies typically employ a variety of data collection strategies including qualitative and quantitative techniques (Hakim, 1987; Yin, 1999). My primary research method is mostly qualitative due to the nature of my research questions, which sought to uncover, describe, and interpret teachers' experiences in a particular context. The emphasis of my research inquiry into teachers' personal experiences is not to test some theory or hypothesis, but to describe and understand what emerged from this project.

The purpose of the study lends itself to a case study research approach. Merriam (2001) states that the case study is suited to research questions that seek to investigate "complex social units consisting of multiple variables of potential importance in understanding the phenomenon" (p. 41). This research project did not seek to control the experiences of teachers or other research conditions in order to predict some single

variable. Rather my purpose was to get the whole view, to look at the real-life experiences of teachers as they grappled with learning about technology in a problem-based framework. As Stake (1995) qualifies, the "case researcher tries to preserve the *multiple realities,* the different and even contradictory views of what is happening" (p. 13).

Furthermore, according to Merriam (2001), qualitative case study research can also be defined by its unique features, which are particularistic, descriptive, and heuristic. This study is particularistic because it focuses on a particular phenomenon. This study is also descriptive in that it includes as many variables as possible and gives a detailed description of teachers' experiences with problem-based learning as a model for professional development in technology integration. Lastly, this study is heuristic as it strives to discover and offer to the reader a greater understanding of how some teachers in a particular setting experienced problem-based learning.

The parameters of the study were bound by the experiences of eight Vancouver secondary school teachers as they engaged in learning about technology integration within a problem-based learning environment. The framework of the study was embedded in this context. Merriam (2001) discusses the notion of the bounded system as a instance of some issue, idea or concern and asserts that if there is no end to the data that could be collected then "the phenomenon is not bounded enough to qualify as a case" (p. 28). There was a clear end to the amount of data that was collected in this study; the amount was dependent on the number of participants and a specific time frame between March and June 2001.

Site and Setting

This study was carried out between March and June 2001 with a group of eight teachers who at the time of this study were all teaching at a secondary school in an urban centre in British Columbia. This school was built in 1964 and is located in a multi-ethnic middle income neighbourhood. The school has a student population of approximately 1300 students in grades eight through twelve and a staff of 95 teachers. The school has students from over 60 different countries and 36 languages are spoken within the student population.

Full time teachers at this school are assigned eight blocks of 80-minute lengths over a two-day cycle. One of these blocks is a teacher's preparation block. Teachers typically see each class of students, three times a week.

At the time of this study, teacher access to computers at this school was limited. There was one general-purpose networked computer lab with 30 computers, which any teacher could book for his or her class; the library had nine computers for general use. There were also two computers for teachers in the staff room; although, at the time of this study, these had limited functionality. The operating system on these computers was Windows 3.1 and these computers were not networked. Although approximately one third of the teachers at this school had at least one computer in their classrooms, the majority of these computers were old, not networked, and used mainly for processing grades for a school-wide computerised grading system.

I have been a teacher at this school for 11 years. At the time of this study, I was a full time teacher as well as Teacher Leader in Technology Curriculum Integration. Although I was not given any time in my regular teaching day to carry out my duties as

Teacher Leader, I was responsible for promoting the use of information technology across the curriculum. My goal as Teacher Leader was two-fold. First, I wanted to provide teachers with more authentic learning experiences that only met their immediate needs with using information technology in the classroom. Secondly, I wanted to develop some framework for sustained and supported professional development in technology integration in the school. I ran a weekly computer drop-in clinic for teachers during the lunch hour prior to and during this study. About six to eight teachers made use of this opportunity but as the school year progressed, and demands for their time increased, attendance dropped to about two to three teachers. Teachers that regularly made use of this lab time however, wanted to learn about computers and how to use certain applications like PowerPoint and spreadsheets, rather than on integration strategies. I did not feel I was accomplishing my goal to promote technology integration in the classroom, but I realized that some teachers needed to feel more comfortable with using the technology before they could begin to see ways to integrate these technologies in their classrooms.

At this school, I was also a member of the Professional Development Committee. In a teacher survey conducted in the fall of 2000 by the committee, a majority of teachers at the school choose information technology training as one of their top three priorities. Teachers in the Vancouver school district typically have five professional days throughout each school year; two of those five days are district-and provincial-wide professional days. A third day is usually reserved for departmental planning days, leaving only two other professional days. These days are planned by the school

professional development committee who usually invites a guest speaker on some theme followed by workshops on related topics.

My experience in planning and attending such episodic professional development has been less than satisfying. As the literature suggested in the previous literature review, effective teacher professional development needs to be teacher-driven, teacher-owned and supported throughout the school year. Although I helped plan a Technology Professional Development Day, I felt frustrated knowing that teachers needed more time and more training than a couple of workshops to understand and make more effective use of networked computers in the curriculum.

Selection of the Case

When I was hired to be the Teacher Leader in Technology Integration at this school for the school year 2000-2001, I was at the time on a full year's educational leave. I was invited to speak to the staff in June 2000 on my goals and plans as Teacher Leader for the next school year. While at the school, the vice-principal asked if I had any ideas for a district initiative in technology integration that offered each high school a $10,000 grant. In order to receive the funds, each school had to submit a proposal that focused primarily on teacher professional development. No money was to be spent on hardware or software. The vice-principal told me that no one on the teaching staff had come forward with any plans.

This was an opportunity I did not want to miss. I consulted with the school librarian who was also Chair of the School Technology Committee at the time and several other teachers and proposed the following plan, which was accepted by the administration. My plan was to work with no more than nine teachers who would each be given a total of ten

release days from their regular teaching load. This number was chosen in order to provide as much release time as possible for ten people, myself included. I wanted to give a small number of teachers more time rather than give a larger number of teachers less release time. I wanted teachers to have time to reflect on what they were learning and participate in collaborative work with other teachers.

I first spoke to the technology committee at the school about this project for their input into the process of inviting teachers to participate. I explained that teachers in the group would be given opportunities to work collaboratively using problem-based learning as a framework to learn about networked learning and technology integration. It was my intent that participation in this study be as purposeful and practical as possible for teachers. I also explained why a problem-based learning approach to teacher professional development in technology use and implementation was chosen. One reason was to simply provide teachers with first hand experience of PBL. Another reason was to model a teaching and learning approach that changes the learning environment to a more student-centered one. This shift from teacher as expert in a teacher-centered classroom to facilitator in a student-centered classroom is necessary for effective integration of new technologies (Bates, 1995; Leu & Kinzer, 2000). Problem-based learning also addresses some of the necessary conditions for successful staff development as discussed in the literature review.

I explained that my role was a dual one; I was a problem-based learning facilitator and researcher. As facilitator, I worked collaboratively with teachers and guided the development of their understanding of the role of technology in the teaching-learning process and assisted them in some technology skills acquisition. My role as facilitator in

this project was to encourage and assist teachers to consider what effective technology use in the classroom might look like and to provide them with some skills to begin to implement a framework that deals with successful networked technology integration into the classroom.

My plan was to first meet with the school's eleven teacher leaders at their monthly general meeting to describe the project, my role and invite their feedback. At this meeting in early January 2001, I made arrangements with the other teacher leaders to speak at their monthly departmental meetings. The response from the teacher leaders was very encouraging and several teacher leaders within two weeks put me on the agenda for their next departmental meetings. At those meetings, I again described the project, outlined the project goals, and the research design. It was after these departmental meetings that individual teachers began to come forward with their intent to participate. The deadline for signing up for this project was March 1, 2001.

Three out of the eleven teacher leaders decided that teachers in their departments were not interested in the project. I was surprised by that reaction since, I had informally described the project individually to at least three teachers in one of those departments and they were very interested. I decided then that I needed to speak at a whole staff meeting to make sure that all teachers had the information to decide if they wanted to volunteer for this project. This I did at the staff meeting at the end of February.

I had earlier decided that should more than nine teachers volunteer to participate in this project, the chairperson of the Technology Committee and I would arbitrarily decide who would be in the project. Participants were asked to submit in writing their reasons for wanting to join this project. Because I wanted teachers to work collaboratively, I

thought it would make sense to have teachers grouped according to similar teaching content areas. I hoped that I would not have to make this decision but knew that should this be the case, the selection process would need to be transparent. Teachers in the school knew the process should more teachers apply than there were spaces. After a total of eleven teachers signed up for this project, I spoke with individual teachers who had expressed interest early in January but had not put in writing their reasons for joining the project. Three teachers at this stage decided to withdraw their names from the project. One teacher indicated that she did not want to be subjected to a selection process and another teacher indicated that since he was not strongly committed to the project he did not want to usurp any teacher who was. Another teacher asked that her name be withdrawn from the list since she felt that she would not be able to cope with her teaching load and starting a new project.

The number of teachers who indicated their desire to participate was now at eight and there was therefore, no need to make any decisions regarding who would participate in the project. The group of teachers was confirmed and I notified everyone. One teacher at this stage began to have doubts about whether he would be useful as a participant in a research project. He wanted to learn about computers to suit his own professional needs and did not feel that he could be a contributing member to the group. I spoke with him privately a few times and we discussed his reasons for joining the project. He was very interested in problem-based learning and wanted to acquire some technology skills but was reluctant to commit to working collaboratively with the group. I told him that because this was a research project which was going to look at teachers' experiences with problem-based learning as a model for learning about technology

integration, his participation would be interesting and contribute to understanding teacher attitudes and problems with collaborating with other teachers. I assured him I had no problems with his participation in this project. He decided to stay.

Throughout the project, teachers met as a group at the school and made use of a computer lab available for teachers at the school district office. Because the school lab was typically reserved for teachers and their students at the school, it was difficult to book the lab for whole days for this project with the volunteer teachers. Teachers also said they preferred to work off-site in order to get away from the daily demands of the workplace. Teachers in this project also collaborated online using courseware called Blackboard. Some used computers in their own classrooms or at home after school hours. Seven of the eight participating teachers had access from home.

Participants in this study were given the following problem at our first group session at the school board offices:

> The Internet has arrived in your classroom! You are feeling the pressure from administrators, parents and students to use this technology in your classroom. You would like to learn more about how to use the Internet for teaching and learning but you are not sure how to go about it. Your department teacher leader has asked you to prepare a brief oral report on some issue related to teaching with technology and create a web site with activities for students in your classroom.

Initially, teachers worked in small groups of four and later as a whole group. They met seven times as a whole group for whole day sessions. They also met at lunch times in smaller groups that they initiated and organized by themselves and some teachers scheduled times with me individually.

The Participants

As of March 1, 2001 there were eight participants in this project. One participant withdrew from the project one month later.

Table 1: Participants and Years Teaching Experience

	Years				
Name	**0-3**	**4-10**	**11-19**	**20-25**	**25+**
Nancy	x				
Steven		x			
Glenda			x		
Irene			x		
Evans			x		
Aaron				x	
Ivan				x	
Leonard					x

Six of the eight teachers in this study had more than 16 years teaching experience; one of these six teachers had been teaching for almost 30 years. Of the other two teachers, one has taught three years and the other has taught seven years. The teachers' subject areas varied but three teachers did teach within the same department but did not teach the same grade level. The teachers' subject areas included Mathematics, Social Studies, English, Special Education and Physical Education.

Data Collection Procedures

Data were collected from two in-depth semi-structured interviews with each teacher, field observations of organised group sessions and impromptu meetings with participants, a pre- and post-questionnaire and lastly, online data from computer mediated discussions.

Observation

I recorded my observations of teachers' experiences with problem-based learning in the group sessions and unplanned encounters with participants in a journal that I kept throughout this project. The data I gathered included information on the context, the participants, and the activities and interactions of the teachers. I also noted my own behaviours and responses since my role as active participant in the project was an important factor in this project. Merriam (2001) defines the role of the participant as observer as one where the researcher's role as observer is subordinate to the researcher's role as participant and notes that the interdependency between the observer and the observed can affect what is observed. Those effects were also noted and this interdependence proved to be a major challenge for me in this project.

Interview

I conducted two separate interviews with each teacher in the project and I asked the same questions of each teacher at each interview. The first interview has held about two to three weeks into the project. The second interview occurred at the end of the project. These interviews were semi-structured or open-ended to allow for phenomenological input from participants (Palys, 1997). In other words, although there were several questions that I asked all teachers, the interview itself was more conversational with

follow-up questions or probes and discussions based on individual teacher responses. All interviews were taped and transcribed using Merriam's (2001) interview log as a model. This organisational strategy provides exact quotes or phrases that are coded to a tape counter where the exact location of the words is easily found.

Self-Administered Questionnaire

A self-administered questionnaire was given teachers at the beginning of the study to determine their previous computer experience, level of use in the classroom and awareness of computer integration strategies in the classroom. This same questionnaire was given to participants at the end of the study to note if there was a change in their self-perceptions in these areas.

Online Data

Online asynchronous group discussions were conducted using computer mediated conferencing software. These discussions were downloaded and used as a source of data as was participant email. Merriam (2001) points out that electronic sources of communication can have unique effects on the information that is being transmitted. She notes that time for reflection in asynchronous discussions, ability to articulate responses in writing, and knowledge that an online response is visible to all and permanent, are all variables that can affect the study. Observations on the differences in teachers' behaviours online and face-to-face were noted.

Analysis of the Data

All research is a search for patterns
(Stake, 1995, p. 44)

As I began to collect data in this project, I started to look for emerging ideas and themes. I started to create categories and applied the data to them. As more data was collected, I re-arranged and refined my organisational system. I used this approach in my data analysis having read about the constant comparative method of analyzing data described by Glaser and Strauss (1967). Their approach made sense to me as my overall research purpose was to discover and induce from the data what teachers were experiencing in this project. I did not begin with any pre-determined categories to fit the data, as that would defeat the purpose of my research. Using a problem-based learning theoretical framework, however, I had some sense of what some categories would likely be, as I started the study. Some of these categories such as collaborative learning, role of the problem-based facilitator, and the quality of an imposed problem in problem-based learning did show up in the data; however some categories that did emerge in this study were unexpected, particularly teacher's experiences with asynchronous online collaboration.

Validity and Reliability

Merriam (2001) suggests that some basic strategies to enhance the trustworthiness or validity of qualitative research are triangulation, member checks, and peer examination.

Triangulation

Stake (1995) describes triangulation as a strategy to help the researcher achieve accuracy in his or her descriptions, or as he writes, quite simply "to get it right" (p. 107).

Triangulation involves using multiple methods of data collection that are cross - referenced to validate the phenomenon being considered (Merriam, 2001). Mason (1996) notes that triangulation at its best encourages the researcher to approach the research questions from different angles and in a more rounded and multi-faceted way. In my analysis, I used data from interviews, my observations and online documents to see if the unit of analysis was the same at other times and with other participants.

Member Checks

I asked participants in this study to confirm my tentative interpretations of their experiences both informally during the research and formally as the results were written. I emailed sections of the results that related to individual teachers and I asked each teacher to suggest any changes and give general feedback on the accuracy of the report. One teacher responded and did not request any changes be made.

Peer Examination

I asked two colleagues to provide feedback on my findings. One colleague works as a Learning and Information Technology Consultant at the Vancouver School Board and is familiar with issues related to in-service training for teachers in technology integration. My other colleague works at Distance Education at the University of British Columbia and has expertise in problem-based learning and online collaboration.

Permissions and Clearances

The proposal for this study was approved by the University of British Columbia Behavioural Sciences Screening Committee for Research and Other Studies Involving Human Subjects. In addition, I obtained permission from the school board through the

principal of the school where I conducted the research. Teachers in this project signed consent forms that gave me permission to use data collected from interviews, transcripts of the computer conferences, email, questionnaires and other teachers' writings.

Calendar of Events

The list of participants was finalised on March 1, 2001. The following is a schedule of planned meetings and collaborative group work with all teachers. Some teachers also met informally on their lunch periods without me during this project. Interviews began after the first meeting and final interviews were conducted in June.

March 7

- Met with the eight teacher participants
- Introduced the research project
- Teachers answered a self -administered questionnaire
- Teachers were given an overview of problem-based learning
- Teachers were put in groups to begin the process

April 19

- Teachers met to work on their projects
- I provided training to those teachers on topics requested by teachers

May 15

- Teachers met as a group to work on projects
- I worked with groups on their projects

May 16

- Teachers met as a whole group to work on their projects
- Had discussions with teachers on effective use of technology in the classroom

May 31

- Teachers met as a whole group
- I provided group training on a model for integrating the Internet into the classroom

June 4

- Teachers met to continue their projects

June 12

- Last day for teachers to meet as a group
- Teachers completed self-administered questionnaire

June 19

- Lunch with participants

CHAPTER FOUR

FINDINGS

As stated earlier, the general purpose of the study was to examine the use and possibilities problem-based learning offered as a context for participants to learn about and teach with networked technologies. The main objective was to describe the experiences of practising high school teachers as they engaged in a problem-based learning project that focused on learning how to integrate networked technologies into the classroom. Using a problem-based learning model also provided teachers with first hand experience of PBL as they constructed personal knowledge of computer use in their classrooms.

Eight teachers from an urban high school participated in this study. A $10,000 grant from the school board for this project allowed each teacher including myself approximately eight days of release time. The teachers met as a whole group on seven separate occasions and sometimes worked in smaller groups that did not always require my presence.

Since case study research requires a rich literal description of the phenomenon being studied (Merriam, 2001), I start with detailed descriptions of the participants that include their reasons for joining the project, their prior experiences with PBL and understanding of networked technologies in the classroom. Then I present findings relating to teacher collaboration, teacher experiences with the problem-based learning process and my role as problem-based learning facilitator.

The Participants

At the beginning of the project there were eight volunteer teachers. One teacher, however, withdrew in April, citing that her workload made it too difficult to continue participating in this study. The data I collected on participants' experiences in this study come from various sources: face-to-face interviews with participants, a pre- and post-questionnaire, participant writings, and my own observations throughout the study.

At our first group session, I also gave each teacher a journal with the hope that they would record their reflections, responses or any other ideas about this project. Initially, two teachers did systematically contribute their journal items to me but as the project progressed, only one of those teachers continued to record and submit journal items. Other teachers submitted emails or informally passed along their responses in brief encounters in the hall during lunch and whenever it proved convenient.

Ivan

Ivan has been teaching high school students in several subject areas for 20 years. I have worked in the same schools as Ivan for most of my teaching career. In fact my first teaching job was working with Ivan in an alternative school that had a staff of five adults and 20 students. After four years, Ivan moved over to the main high school and I followed a year later. We worked collaboratively at the alternative school and developed a professional friendship that has lasted for 15 years.

Ivan has a networked computer in his classroom, but mainly uses it for processing marks and accessing his email with a Hotmail account. He has a computer at home but does not get much chance to use it, as his children tend to monopolize it. Ivan saw this project as an opportunity to learn more about computer technology in order to make

better use of it in his classes. One of his concerns with technology use in his classrooms was his students knowing more about the technology than he:

> *Kids having more knowledge than I do concerns me. I'm still a computer neophyte. Having done some work with you last year--you've opened a number of doors. I haven't practised and I'm still lost at times about how and what I want to do. I know that these options are there for me - I can see how to apply them. But I still can't use a computer well just yet, but down the road with a little more repetition, I'll get there.* (Ivan, interview, April 10, 2001)

I had worked with Ivan individually prior to this study to help him learn some basic computer skills and some integration strategies. We had worked together on creating and posting on the school server a collaborative learning project for a senior social studies class. He had never before promoted the use of technology in the instructional design of his student projects. In these sessions he was always very excited by the potential of this technology, but he felt he needed more time and practice to improve his own computer skills before he could envision using the technology effectively as a teaching/learning tool.

Irene

Irene has been a teacher for almost 17 years and worked at the time of this study as a special needs teacher. She has a small office in the school where she works individually with students who have been designated by the district as special needs students. She rarely used a computer in her work prior to the study and felt she had next to no computer skills. Although she has had some previous training in computer use, these training sessions had not resulted in any transference into her practice:

I've gone to workshops but have not had a chance to put what I've learned into use—into applying it. We need mini sabbaticals to immerse ourselves—I need to be taken out and trained for a month or two. (Irene, interview, March 14, 2001)

She had a computer in her office but it was slow, unreliable and using it with her students was more often than not a frustrating experience. She joined the project because she felt it was important to investigate ways to integrate networked technologies into her learning centre and other remedial settings. She also wanted to be able to help her students do research on the Internet:

I'd like to help my students do research on-line. Kids get lost on the Internet. It's too bulky and big for kids. They end up wasting their time. I'd like to go with students online to look for answers. (Irene, interview, March 14,2001)

Irene had had some experience in co-operative learning but had not used problem-based learning in her practice.

Steven

Steven has been a teacher for seven years and has taught several subjects at a high school level. Although, Steven was sceptical about the uses of technology in his content area, he wanted to participate in this project, which would give him time to explore the potential of using networked technologies in his classroom:

I know that I will not use computer technology in my teaching unless I can be involved in a project such as this...I can see its [networked computer] *application for research projects and for allowing students to communicate with each other on school related topics. Also, I'd like to use it to find classroom materials, which*

I have tried on my own but, have been unsuccessful with thus far. (Steven, correspondence, Feb.15, 2001)

Steven often commented on and felt frustrated by some of the barriers to using technology in the classroom such as access to reliable equipment, and lack of teacher training. He had taken a few professional development workshops but nothing that stood out in his mind.

I don't think you can show teachers how to use technology effectively. There's a process you have to go through. You can't jump steps—there's a certain evolution. (Steven, interview, March 21, 2001)

He felt that the classroom as a place for student interaction and collaboration could not be replicated in an online environment and was concerned about the quality of teacher-student interactions online. For Steven, the face-to-face engagement and emotional connection between teacher and students were the critical factors in successful student learning:

If kids don't care about you, they are so resistant to learning. In a supportive stable classroom, they feel safe and that it's a worthwhile use of their time... When I see improvement in a student, it's always when I've worked one-to-one with that student. (Steven, interview, March 21, 2001)

Although Steven could see that teachers could have that kind of relation online, he did not see much advantage for doing so with his students since the opportunity already existed face-to-face. Rather, he saw computers in classrooms being used more as resource tools.

Steven also reported using problem-based learning in the past years with students and that as a learner he himself had had some genuine deep learning experiences with PBL. He described how one PBL project was a memorable experience for his students and himself:

> *There was one project we did in Grade 8. We were drawing out this big map-it was a whole class project and we started with a small map and blowing it up really big, scaling it to make it really big. And I had never done anything like this before and I just took on way too much. We were doing this map and it was half the size of this classroom. It was huge and we were trying to piece this out together and every time we would try and piece it together—it wouldn't fit. It was a horrible failure. And so many students come up to me year after year and talk about the map. I didn't know what I was doing—so the whole class was trying to figure it out.* (Steven, interview, March 21, 2001).

Aaron

Aaron has been a physical and outdoors education teacher for almost 22 years. He joined the project primarily because he wanted to learn more about computer technology. However, a month into the project he felt he should withdraw because he felt he was not contributing much to the group. He was extremely busy with extra-curricular activities in the school. He did not have Internet access at home nor did he use a computer at school and found collaborating with the other teachers in the group problematic for a number of reasons. He also could not at first see any direct applications to his content area. We spoke at length about his concerns during one of his preparation periods. I assured him that his participation was valuable to the study and he decided to stay.

Aaron reported that he had had extensive experience in problem-based learning:

> *PBL has been an integral part of my learning of athletics and the outdoors. Initially, athletic success (team) was easy to realize as I saw coaches implement systems in a closed setting (rote learning and fact retention as an academic equivalent). At university I was introduced to a totally new and rather unique (and still is) approach which I have come to understand as a PBL approach...When I started wilderness education, I realized that this was the ultimate PBL situation. Since the environment is constantly changing, each new scenario must be evaluated and dealt with accordingly—sometimes in split-second fashion...The only way to survive is to be able to use PBL because of its speed and extent of applications. When there are so many variables that interact, it is the only solution.* (Aaron, correspondence, March 7, 2001)

Aaron, however, initially reported that he did not think this approach to learning would work in a regular class, nor was he sure it would work as a model for training teachers although he felt that problem-based learning did have enormous potential:

> *Could this system work for a regular class—not a chance. I'm not sure it could work for teachers as I'm having a hard time moving this up my priority list. The potential however is enormous...*(Aaron, correspondence, March 7, 2001)

I agreed to meet with Ivan and Aaron after school hours to practice some computer skills and talk about integration strategies. We spent almost an hour discussing issues related to using technology in the classroom and in particular Aaron's content area. I could see his eyes light up as he started to realize some direct applications and he then began to get

started working on his particular project. Later, he reported that this session helped motivate him to become more actively involved in the project:

> *I had some grave reservations at the start, but I think because of my background and experience I really enjoy learning...The* [session] *was outstanding and I realized I knew more than I thought I did. I found my way around the computer quickly and made few mistakes...I will put this* [project] *higher on my priority now.* (Aaron, correspondence, March 24, 2001)

Nancy

Nancy was the youngest member of the group and has been teaching for three years in two subject areas. She was very keen about technology integration and had been accepted in a Master's program where she planned to focus on social studies and computers in education:

> *I have kept myself relatively up-to-date with new initiatives in incorporating technology into the classroom/curriculum, yet I often find that I don't have enough extra-time outside of work to implement my ideas. I am hoping this project will give me a chance to really put to use all that I have learned to date...Technology in the classroom as something that enhances the curriculum excites me and I plan on doing further graduate studies in this area. I would be highly motivated and excited to be a part of this project.* (Nancy, correspondence, Feb.15, 2001)

As a new teacher, Nancy felt that the pressures of her workload and her personality sometimes prevented her from experimenting with more student centred learning approaches such as problem-based learning:

I have trouble letting go—it's part of my personality. It's going to take some time. I control the lesson so much. I 've been trying to let go but I know I'm controlling...I'm going to take in all I can about PBL but its enough of a workload to just keep up. (Nancy, interview, March 29, 2001)

Leonard

Leonard was a senior math teacher and has been teaching for almost 30 years. He had very specific reasons for joining this project:

I have had a great deal of interest for many years in the use of computer technology as a teaching aid in mathematics. I use a number of software programs regularly in my teaching and would like to extend that practice with use of the Internet.

(Leonard, correspondence, Feb. 15, 2001)

At the start of this project, Leonard had strong beliefs on the role of technology in the classroom. He argued that in math education, teachers were a primary source of knowledge and teachers' roles were to impart that knowledge to students. Having ready access to an overhead desktop projector and a reliable networked computer would give a teacher the necessary tools to better demonstrate mathematical principles:

We [teachers] *should all have overhead projection capabilities...Teachers are still the main source of learning and it will stay that way for a long time...we have to impart some knowledge and send them* [students] *along their way.* (Leonard, interview, March 29, 2001)

Evans

Evans has been teaching for 16 years. He has a networked computer in his classroom, which is used mainly as a teacher tool for recording student grades, organising

lesson plans and other resources. Evans would like to have more computers in his class for student use but limited funds at his school have made it difficult to acquire them. Evans joined this project to learn more about technology integration in his classes and improve his own computer skills. He was also interested in problem-based learning

> *I want to find out more about using computers in my teaching. I don't know anything about a PBL approach and I want to find out what it's about.* (Evans, interview April 14, 2001)

Evans has a somewhat eclectic approach to teaching. He provides student-centred resource rich learning environments as well as using more transmission approaches to delivering course content. Evans and I both taught in the same department for a number of years. His classroom was next to mine and we had an open door policy - we entered each other's room at any time during class time when we need to discuss something, share a resource or ask a question when we needed immediate support.

Evans felt that most of what he already knew about computers was self-taught, although he did attend some formal training workshops when computers first entered the scene:

> *I haven't had any formal training, but I did some preliminary and elementary workshops years ago when Commodore 64s came out. There were workshops on DOS and how to use it and I took a few courses. But nothing on integration.* (Evans, interview, April 14, 2001)

Glenda

Glenda has been a teacher for almost 15 years. She joined the project for a number of reasons:

there is so much more I need to learn about the use of the computer in teaching. It is also important that I as teacher leader show a positive attitude towards recent developments in technology in teaching and that I demonstrate collegiality in my support for the work of my peers. (Glenda, correspondence, Feb.15, 2001)

Glenda attended the first group session, but decided later to withdraw from the project about a month later. In a written note to me, she explained that her workload and the need to concentrate on helping her students prevented her from continuing in this project.

Participant Self-Perceptions of Technology Skills and Technology Integration

The participants filled out a questionnaire at the beginning and at the end of the project. The pre- and post-questionnaires were identical and teachers did not put their names on these questionnaires. The purpose of the questionnaire was to give teachers an opportunity to learn about and assess their own understanding of technology skills and teaching with technology. I also wanted to find out if there were any changes in their self-perceptions at the end of the study. Dr. Donna Baumback and Mary Bird from the University of Central Florida designed the original questionnaire and gave me permission to use and modify their questionnaire on August 16, 2000. The original questionnaire contained 16 sections and I eliminated five sections. I felt the sections I chose for this questionnaire would give me enough information on how teachers in this project used and integrated the Internet and how they rated their level of mastery. The sections I chose to eliminate were either too technical in nature, outdated, or not relevant to the purpose of this study. For example, I eliminated a section called "The Media Specialist's Role in Telecommunications and the Internet." In the school where the study was conducted

there was no media specialist. Another section called "Publishing on the Internet" I felt was covered in other sections.

Eight teachers completed the self-administered pre-questionnaire on March 7, 2001 and five teachers completed the post-questionnaire at a final luncheon on June 14, 2001. Two teachers handed in their post-questionnaire a week later. Teachers did not put their names of their surveys and thus there are a total of eight pre-survey responses and seven post-survey responses.

The teachers read through the question items and we discussed their meaning informally as a group at our first working session in March. The teachers then read through the sections of the questionnaire and rated themselves according to the following scale:

Level 1: Unaware

Level 2: Aware

Level 3: Competent

Level 4: Mastery

The following contains a description of the results of each section of the questionnaire:

Personal and Educational Uses of Networks

In the pre-survey, one teacher felt that he or she did not understand how the Internet works, nor could this teacher identify any professional uses for networks. This teacher chose the unaware rating. Two teachers could identify some uses of the Internet, but felt they did not have the skills or access to use the Internet. Four teachers rated themselves as competent by noting that they could describe what a network does, and its personal and professional uses. They also had access to the Internet. One teacher chose a mastery

level rating in this area. This teacher used networks on a daily basis and actively participated in school organizations that needed advice or information about networks.

There was a slight difference in answers in this category in the post-survey. All teachers felt they understood how the Internet works and could identify professional uses for networks. One teacher felt that he or she could now identify some professional uses of the Internet, but did not have the skills or access to use the Internet. Five teachers responded they now felt competent that that they could describe what a computer network does and how it can be useful personally and professionally.

Table 2: Summary of Teachers' Self-Assessment of Personal and Educational Uses of Networks

	Pre-Survey Responses	Post- Survey Responses
Level 1: Unaware	1	
Level 2: Aware	2	1
Level 3: Competent	4	5
Level 4: Mastery	1	1

Email

In the pre-questionnaire, three teachers reported that they did not use email or any other online communication tool such as listservs or newsgroups. They rated themselves as unaware. Three other teachers reported they had mastered email and regularly used email to communicate with other individuals in an effort to improve their teaching and students' learning; thus they rated themselves as aware. The remaining two teachers rated themselves as competent in their use of email but did not use it regularly to support their professional practice.

In the post-survey, all teachers rated themselves as competent in using email. They could now read, send, reply, and interpret domain names. Two teachers noted that they still had no knowledge of listservs but one of those two could locate newsgroups. The remaining teachers rated themselves as either competent in or had mastery of email, listservs, and newsgroups. Mastery was described as being able to contribute to these groups and access listserv or newsgroup archives.

Table 3: Summary of Teacher's Self-Assessment of Use and Understanding of Email

	Pre-Survey Responses	Post- Survey Responses
Level 1: Unaware	3	
Level 2: Aware	1	
Level 3: Competent	2	5
Level 4: Mastery	2	2

World Wide Web

In the pre-questionnaire, three teachers noted that they did not understand what the World Wide Web was and rated themselves as unaware. Three teachers felt they understood what the World Wide Web was and could navigate through it. They understood what a URL was and could enter a specific web address. The remaining two teachers gave themselves a mastery level score in their understanding and use of the Internet. They could locate and access subject specific information, use both browsers and several search directories.

In the post-survey all but one teacher felt they had mastery level in this category. Mastery level was described as being able to locate and access information, use a search engine, save text and pictures for use in their own web pages and use both browsers.

Again this change in teachers' perceptions is also not surprising since teachers worked on projects where they specifically had to learn these tasks.

Table 4: Summary of Teachers' Use and Understanding of the World Wide Web

	Pre-Survey Responses	Post- Survey Responses
Level 1: Unaware	3	
Level 2: Aware	3	
Level 3: Competent	1	1
Level 4: Mastery	1	6

Evaluating Internet-Based Information

Two teachers, in the pre-survey rated themselves as unaware since they indicated on the questionnaire they did not know anything about evaluating Internet-based information and three teachers understood that there may be problems with Internet-based information but were unclear about it. Three teachers felt competent as they indicated they could identify and demonstrate problems related to accuracy of information on the Internet and always evaluated resources before using them. No one reported that they had mastery level in this area. Mastery level was described on the questionnaire as being able to find sites that gave them helpful information about evaluating resources. Furthermore, they did not instruct their students how to check the accuracy of Internet resources, nor did they provided them with guidelines or checklists for evaluating resources that students used in their school assignments.

There were some changes in responses in the post-survey. One teacher described herself or himself as aware that there may be problems with Internet-based information

but was unclear about it. Four teachers rated themselves as competent in this area. They could identify problems related to the accuracy of information of Internet resources and always evaluated the resources before using them. Two other teachers in the group now felt they had mastery level, which was defined as the ability to find Web sites that contained helpful information about evaluating web sites and to instruct their students on how to check the accuracy of the resources from the Internet. These teachers provided their students with guidelines or checklists

Table 5: Summary of Teacher's Self-Perceptions of Skill in Evaluating Internet-Based Information

	Pre-Survey Response	Post-Survey Response
Level 1: Unaware	2	
Level 2: Aware	3	1
Level 3: Competent	3	3
Level 4: Mastery		3

Teaching and Learning about the Internet

In the pre-survey, one teacher felt that he or she could not identify any need for teaching students about the Internet and could not identify any use for Internet resources in the classroom. Six of the seven teachers reported that they did not use Internet resources in their instruction even though they understood that the Internet may be a valuable resource for students and that information skills are important. They rated themselves as aware.

In the post-survey, no teachers reported they could not identify any need for teaching students about the Internet. Three teachers felt that even though they were aware that the Internet might be a valuable resource they did not teach students how to locate or use

Internet resources. They rated themselves as aware. The three remaining teachers however, all felt they had mastered this level. Mastery was described as helping students use, adapt and integrate resources and information they find on the Internet to complete assignments. In addition, at this level teachers used Internet resources whenever appropriate and teachers could not imagine teaching without access to the Internet.

Table 6: Summary of Teacher's Self-Assessment of Use and Knowledge of Need for Teaching and Learning About the Internet

	Pre-Survey Response	Post- Survey Response
Level 1: Unaware	1	
Level 2: Aware	7	4
Level 3: Competent		1
Level 4: Mastery		2

Using Internet Resources in Instruction

Seven teachers reported that they understood that the Internet may be a valuable resource and that information skills were important; however, they personally did not teach students how do use Internet resources. One teacher of the seven did look for Internet resources that were appropriate in the classroom but did not help students access them to reach instructional goals.

In the post-survey, four teachers now felt competent in their use of Internet resources in their practice and that they regularly look for Internet resources. Again, this is not particularly surprising, since much of their time was spent on exploring the Internet for resources in order to address the goals of their own Internet projects.

Table 7: Summary of Teachers' Self-Assessment in Their Use of Internet Resources in Instruction

	Pre-Survey Response	Post-Survey Response
Level 1: Unaware	1	
Level 2: Aware	6	2
Level 3: Competent	1	4
Level 4: Mastery		1

Participation in Telecommunication Projects

Five teachers in the pre-survey could not identify any telecommunication projects or the role these projects would play in the classroom. Three teachers were aware of different kinds of telecommunication projects and the benefit they bring to students, but did not use them in the classroom.

In the post-survey four teaches felt they were aware of telecommunications but did not use them in the classroom; one teacher felt that he or she could not identify any telecommunications projects or role they would play in the curriculum. One teacher now felt he or she could involve students. This teacher knew where to find ongoing projects, how to sign up, and participate and gave a self-rating as competent.

Table 8: Summary of Teachers' Self-Assessment of Their Participation in Telecommunications Projects

	Pre-Survey Response	Post Survey Response
Level 1: Unaware	6	1
Level 2: Aware	2	5
Level 3: Competent		1
Level 4: Mastery		

Utilizing Internet Resources in Instructional Materials and Student Projects

In the pre-survey, three teachers reported that they were not aware of any Internet resources that could be used in creating instructional materials. Four teachers admitted knowing that resources from the Internet could be utilized, nevertheless they did not use them or teach students to use them. One teacher clarified by noting that he or she did not teach students to use these resources but did use them to create instructional materials such as handouts or multimedia projects.

In the post survey, three teachers reported that they knew resources could be used but they did not use them of teach students to use them. Three teachers rated themselves as competent in this level. Competency meant being able to locate appropriate information in a variety of formats from the Internet and use software that converted them to usable formats. In addition, teachers are able to create student projects that require Internet resources.

Table 9: Summary of Teachers' Self-Assessment in Being Able to Utilise Internet Resources in Instructional Materials and Student Project

	Pre-Survey Response	Post Survey Response
Level 1: Unaware	3	
Level 2: Aware	4	3
Level 3: Competent	1	3
Level 4: Mastery		1

Teacher Collaboration in Problem Based Learning

Collaboration among teachers, we don't have enough of that stuff!
(Ivan, interview, April 10, 2001)

In the Beginning

Teachers met for their first group meeting on March 7, 2001 in a meeting room and later a computer lab at the school board. They wanted to meet off-site so that there would be fewer distractions and better access to a computer lab with a fast Internet connection. Besides, it was often very difficult to book the computer lab at the school for teachers to work on this project since it was used regularly by other teachers and their students. Ergonomically, the school board facilities were also much more inviting than the school lab. The computer chairs were more comfortable, the lighting less glaring and teachers enjoyed coming to the board where the overall atmosphere was quieter.

At our first group session, I outlined the project in general, my role as facilitator and researcher, and spoke briefly about problem-based learning. I told the teachers that if they wanted more information about problem-based learning, I would direct them to more resources and share my knowledge of this teaching/learning process. We then looked at the self-administered questionnaire, talked about some of the question items and teachers spent the next 20 minutes completing it.

After lunch we moved into the lab and each teacher was given a handout of the problem with some guidelines and suggested resources. I explained to teachers that although I had also indicated assessment criteria on the handout, this was only to model for them what a problem-based learning assignment might include or look like. I made it clear that there would be no evaluation of their work in this study.

I then put teachers into two groups of four. One group included Leonard, Glenda, Steven and Irene, the other, Ivan, Nancy, Evans and Aaron. The criteria for the groups were based on teachers' content areas, level of computer expertise and willingness to work with particular teachers. I wanted there to be at least one teacher in each group who could provide computer support to the others and I wanted teachers to work on purposeful projects that could be developed and shared by other members of their particular group. I felt that grouping teachers as much as possible by their content area, might produce more purposeful collaboration. I was able to create one group that had two or more teachers who taught in the same department. After one of the teachers withdrew from the project, teachers in the other group all taught in different departments.

In their separate groups on that same afternoon, teachers talked about the problem that was presented to them, what they already knew that might help them solve the problem and what they needed to learn more about how to solve the problem. I informed teachers that they had approximately three months in which to solve their problem and they could schedule their release days as they saw fit. If particular needs of each group were similar, I would arrange for whole group sessions. For example, if each group felt they needed to learn similar computer skills to address the problem, I would provide training for the group. I asked that each group identify a person who would keep me informed of group activities and group needs. One group identified Steven as their group coordinator and the other group chose Evans.

At the end of the day, I showed all the teachers how to login and navigate in a course I had set up in a free online courseware called Blackboard. I called the course Teaching with Technology and teachers where shown where in this courseware they could hold

general whole group discussions and where they could collaborate online with members of their own group. I showed teachers how to respond to a posting and how to start a new topic. I also talked about posting thoughtful discussion items as opposed to simple statements that showed they either disagreed or agreed with comments made by other teachers. Teachers practiced navigating through Blackboard and posting messages.

After our first session, one teacher wrote:

> *Leaving* the [school board] *last Wednesday I really felt that I was getting involved in a worthwhile project. So much so, that when I got home I got online and logged in to the Blackboard site on my mentally challenged 28.8 modem. Glenda had left a message...On the weekend, I got an email from Irene regarding arranging a workshop this week.* (Steven, correspondence, March 13, 2001)

This confirmed some of my own observations and was similar to responses of other teachers of that day. They were all very keen to begin to work on the solving the problem that was presented to them and most seemed comfortable with the members of their group. Another teacher wrote:

> *The afternoon proves even more interesting than the a.m. I really like the way we will be communicating with you and among ourselves. The Blackboard site is neat...The group discussion goes well. We all seem to be pretty much on the same page as we discuss the problem and possible actions that need to be taken in order to solve it. The idea is presented that we will need a training session on how to construct a web site. I think that will be just so cool--I really want to learn this skill. I am anxious to get started. In fact, for the type of personality I am I want to get into*

it right now! I hope I will not become frustrated by the four-month time line. (Irene, journal entry, March 7, 2001)

Problems in Paradise

The two groups met over the next four weeks to begin work solving the problem. They initiated the sessions themselves and met without me present to discuss the problem and how they would begin to work as a group on solving it. After about a month into the study, some teachers were beginning to express some doubts about and frustration with the effectiveness of their group collaboration. Two teachers from the same group both talked about the lack of time during the school day for teachers to get together and actually begin doing any collaborative work on their particular projects:

I'm motivated...we haven't done anything. Our group has done nothing, we haven't had any time. We've met 2 or 3 times. We need to get together with the group. We should be collaborating. (Leonard, interview March 29, 2001)

There's a difficulty organizing people. I don't feel our group has really come together in any coherent way. (Steven, interview March 21, 2001)

Another teacher in the same group felt that it was still too early at the end of the first month to tell how the group was working out. However, she felt her group was mainly addressing their needs for some computer skills training and not on their needs to learn about technology integration. She wrote:

Our group met but only to address the technology part, not the PBL part. And our meeting prior to that also had the same flavor...It has been a little difficult to really gel as a group, I don't think we've really done that yet...but we will gel because I think we're starting to get on top of the technology so that will help us accomplish

this and then we can gel as a group and move forward pretty quick. (Irene, interview, March14, 2001)

Teachers in the other group were also finding it difficult to collaborate but for different reasons. Three teachers in this group had their own agendas and wanted to work on their separate projects. Two of these teachers were already working collaboratively on another project for a course they were co-teaching and wanted to find a way to integrate student technology use into this project. One of these teachers had also sensed some frustration by a teacher in their group who had stronger computer skills. Ivan understood that for some teachers, helping out other teachers who needed much assistance could be very frustrating. Nonetheless, he felt that team members should be willing to take on whatever necessary roles to get the job done:

Can you see people [people with strong computer skills] *being mentors? Because these people have those skills - in a group would they not just get frustrated with the inept neophyte?... You* [any teacher mentor] *should be patient, calm, have to repeat yourself a hundred times until you get the job done. Working in our team--that is never the case.* (Ivan, interview, April 10, 2001)

Another teacher in the same group also felt the lack of collaboration among his group members at this stage of the study. I spend a half-hour with this teacher who wanted the project goals clarified and how to work within the group. I also worked individually with two teachers in this group during their preparation blocks. They needed extra practice with navigating through Blackboard and wanted to learn how to use search engines more effectively. One of the teachers remarked, "*I learned so much with you just sitting down with you for a half-hour*" (Evans, conversation, April 6, 2001). The fourth member of

this group was also feeling isolated. She wanted to spend some time with some of the senior teachers in her group, but was having difficulty arranging times to meet with them.

Role of the Facilitator

It was very difficult for me not to step in at this point and assume a more direct role in the affairs of the group. I could sense some of the teachers were waiting for me to take charge and direct the members of each group. I found I was having many brief chance encounters with several teachers in the hallway, answering specific questions of what they would like to get help with. I felt that some teachers were looking for support from me because they were not able to get the help they wanted from their group.

On April 10, 2001, I met with Steven during the morning fifteen-minute break in the hallway. He reported having problems getting his group to focus on their solutions to the problem and that he was having problems coming up with an idea of how to use the Internet in his particular content area. I promised to drop into his class during his preparation period to discuss these issues. I told Steven that teachers in his group needed to decide how they planned to address the problem and what technology skills they think they needed to have to solve the problem. I also showed him some examples of how he could integrate the Internet into his classes. He seemed to get more excited and confident about generating some Internet activities that he might be able to implement in June.

After the first week of April about a month after our first session, members of each group wanted to have another session to learn more technology skills in order to work on their projects. We got together at the board office. At this session, I showed them a model for integrating the Internet into their classrooms and then how to use some web authoring tools. The teachers spent the rest of the day building web pages. I saw that

they were very happy to have me deliver a training session and talk about what in my view was important to know about technology integration. In an online discussion question on whether or not effective use of technology in the classroom necessarily changes the learning approach from a teacher-centered transmission one to a more student centered self-directed approach, one teacher responded:

> *Not necessarily--I don't think so. The use of the technology can still be extremely structured and at times would have to be. Look at our last session at the board- thank God, Maryjanne was the computer sage on the stage during that session.* (Irene, online discussion April 30, 2001)

When I read the above posting, my own recurring anxiety of being a successful problem-based facilitator surfaced. After the first session, I wrote at length in my journal about the difficulty of moving away from being the teacher in charge. I wrote:

> *I worried that I was going to do too much of the talking at the group session and I made a point of telling the group that after the first session, I was not going to direct this project. I realized afterwards that the hard thing for me to do in problem-based learning is to move from being a teacher in control of the learning and become a facilitator. It's difficult to take a back seat and let others drive their own paths to the problem solution. I hesitated telling them my beliefs and what I have come to know but I wanted to make sure we were moving away from just learning about the technology to learning about teaching with technology.* (Maryjanne, journal entry, March 7, 2001)

I felt a little discouraged after our second group session because I saw that teachers were more interested in learning how to use technology tools rather than discussing and

working out with each other how these tools might promote learning in the classroom. Some teachers in the group were building web pages that contained information such as course outlines or links to other resources. I was trying to steer them into thinking about creating student-centered lesson activities that promoted critical thinking but was feeling that I was not particularly successful. Teachers at this point wanted to improve their own skills and experiment with the authoring tools in Netscape Composer, a web editor. I knew some teachers were grappling with the pedagogy of the Internet, but even so these teachers felt they needed to work on their own skills before they could use the technology effectively in the classroom. One teacher wrote:

> *By effective use of technology, I guess we are asking if teachers are able to use an overhead/slide/film projector; at the same time we are also asking if teachers are able to use those technologies effectively in the classroom that could make a difference in teaching and learning. To me, these are two very different issues. The second one does not take place without the first one being resolved; at the same time, the second issue may or may not be resolved even if the first one is fully addressed.*
>
> (Evans, online discussion, May 1, 2001)

After some reflection, I realized that I was imposing my own agenda for this project and that I needed to let go and let teachers develop whatever skills they felt necessary to meet their own needs. I also realized that the problems teachers were experiencing with collaborating might in fact be very valuable knowledge for them as they try to promote student collaboration in their own classrooms.

Teachers in one group, however, were still grappling with how they could best work collaboratively. Some teachers wanted to work on their own projects and use the group

as support. Others wanted to work on a group project even if it had no direct application to their own classrooms. This one was a struggle for me. I felt it important that for any transference to teachers' classrooms, teachers need to work on a project that they could later implement in the classroom. After all, this was a component of the problem that they were being asked to address.

At six-thirty in the morning, on May 3, 2001, I met with two teachers from one of the groups. This group had become very fragmented and I worried that if I didn't meet with these two teachers separately from their group, they might begin to feel discouraged. My plan was to find some way to motivate them to participate with other group members. Six-thirty in the morning was the only time they could meet as their lunch hour was taken up with extra curricular activities and they both had commitments at home after school. We spent about thirty minutes going over web page construction and the remaining hour, talking about technology use in the classroom and other pedagogical issues such as student motivation, classroom management and effective technology use. One of the teachers was so excited to continue the discussion that he demanded I visit him in his classroom later that day to go over his project. The other teacher also began to envision how he could start to integrate the technology. I could see his eyes light up and his renewed interest in the project. However, I was not sure that I had convinced these two teachers on the value of working collaboratively with other teachers in their group.

Unfortunately after the second whole group session on April 19, a city transit strike occurred. Because of this, the board announced that on-call teachers would not be provided for any purpose other than teacher illness. Teachers had to put off using release time to work on their projects and I worried that any momentum that teachers had

achieved might be negatively affected. I appealed to school administrators to intervene and request special consideration from district officials. After a three-week delay we were granted teacher coverage once again and my administrator urged me to book all the teacher release days sooner rather than later. I spoke with all members of the project to find dates that would work for everyone and we decided upon two back-to-back days on May 14 and 15. Teachers then decided that the other days they wanted release time for would be May 31, June 4, and June 12.

At these group sessions, we addressed the issue of group project versus individual projects and group collaboration versus independent study. I gave teachers my position on these matters and reasons for why I felt teachers needed to work on some meaningful project that they could use in their classrooms. I wanted teachers to use this study as an opportunity to create a student project that reflected effective use of technology. I did not want teachers to simply engage in their own computer skill building exercises. If teachers were engaging in a project that had no direct relevance to what they were doing in the classroom, in my view they would not benefit as much as they might.

At the same time, I wanted teachers to find a way to support and work together to build their personal knowledge of technology integration. Working on their individual projects did not mean that they could not work collaboratively. We discussed this as a whole group and most teachers felt relieved that I was, in effect, giving them permission to work on their own projects. One teacher, however, was keenly disappointed and wrote afterwards:

The morning of the 14th started off well, despite the fact that I had forgotten almost everything from previous sessions. Everything had to be relearned and that was

frustrating, of course. To make matters worse for me it seemed that the others in the group remembered what had been learned in prior sessions much more easily than I did. And when I looked around their work seemed to be much more advanced than mine as well. It seemed that most of them had spent time on their own progressing while things had actually slipped backwards for me. Another set back came when I realized that we would not be working as a group, but rather on individual projects. I did not feel ready for this. I was counting on a group project because I was aware that I had real weaknesses when it came to this technology and I knew I would need the support of the group...in the end working on an individual project worked out just fine, it gave me time to reflect on my unique needs. I was able to wrap my head around it. Initially however, I did feel abandoned by my group. They were all off doing their own individual thing, and didn't feel motivated to help me along; well, at least that is how I felt. I was thankful that [Evans] *was sitting next to me in the afternoon. He seemed to understand that helping me was also reinforcing his own learning process. He seemed to get that and didn't mind pausing to give me a hand.*

(Irene, journal entry, May 14 & 15, 2001)

That evening, reflecting on the day, I realized that I had made a great error by imposing my own position that teachers work on projects not as an exercise to improve their computer skills, but on projects that they could later use in their own practice. The next day, I apologized to the group for my interference in their group affairs and emphasized that the group members should do what they felt was necessary for them to do to work on the problem. I observed a sense of relief from some participants who wanted the freedom to work on projects or tasks as they wished.

Whole Group Collaboration

After this, both groups preferred meeting as a whole group. One teacher had withdrawn from the program leaving only three members and the other group could not arrange any meeting times for all four to attend. Since three more release days for each teacher remained, the teachers decided to organize whole group sessions and the teachers would try to make these sessions if possible.

At the remaining sessions, I offered support to teachers who asked for it, but otherwise I let teachers plan their days as they wished. At some of these sessions, a few teachers needed individualized support with their computer skills, but mostly teachers were able to work fairly independently amongst themselves.

By the end of the study, some teachers felt that working with other teachers sometimes collaboratively and sometimes with other teachers as support persons was helpful. One teacher summarized what other teachers had felt in the group:

> *A bond developed. Everyone was excited and wanted to help each other.* (Leonard, interview, June 15, 2001)

Some teachers found it easier to work with teachers from another group and some bonding seemed to develop naturally. In an email, one teacher wrote of his desire to keep the group working together after the study was over:

> *To keep learning on a long term basis, we should maintain a core-interest group to keep learning and practicing, and the core group will carry the torch in embracing new learners to participate in the project...new topics can and will be generated for project ideas, and new skills and knowledge will be brought forth to make web designing less intimidating, and more collegially, staff across departments will*

communicate and more sharing will take place. (Evans, online posting, April 20, 2001)

Another teacher responded to Evans' posting to thank him for his willingness to collaborate:

I just want to take a minute and tell you that I think your vision of this project continuing as a core group and embracing others as time goes on is awesome...you have demonstrated a spirit of true cooperation in learning. Whenever I had a question or needed a hand, you seemed happy to take the time to give me a hand and in doing so you helped me back on track while at the same time you realized that you were taking the opportunity to reinforce your own learning of a particular piece of this complex puzzle... Your sense of cooperation and responsibility to the group is in stark contrast to the individualism we see rampant in the culture of our schools, and our classrooms. Thanks. (Irene, online posting, May 19, 2001).

One teacher commented on the need for more release days and felt the composition of the group should be more homogeneous in terms of teachers' computer skills. He had been only able to attend five group sessions during this study:

the five days are just not enough. To me those five days are just long enough for me to make some sense as to what I am doing. I think this project should be an on going process, and the composition and the organization of the group should be more homogeneous in skills and in knowledge about the web and the net...At this point, people at different depth of skills and knowledge have undoubtedly different priorities. (Evans, correspondence, June 12, 2001).

Online Collaboration

At our first session, I showed teachers how to post a message in the discussion area in Blackboard. Some teachers had never been in a chat room and online discussions were new to them. They seemed very excited about using this technology.

I decided to use computer mediating conferencing (CMC) software such as Blackboard because I wanted to give teachers greater flexibility to discuss issues related to technology integration in order to address the second part of the problem. The second part asked teachers to present to their departments some issue relating to the pedagogy of technology integration. Given the flexibility of an online environment and the difficulty of finding time during the regular day, it was my hope that teachers would be able to present their ideas, question the ideas of others and debate issues when and where it was convenient for them to do so.

An example of this flexibility was demonstrated when one teacher had to travel to another province shortly after our first meeting as a whole group. She used her group discussion area in Blackboard to keep in touch and continue planning with her group:

> *I have been in _____for most of the week and have had some time to think about a possible unit/lesson project as I watch the 12ft. snow banks melt. I'm thinking of doing something on the Renaissance with art on-line and perhaps some sort of PBL questions. Of course this could change...we'll see. Has anybody else thought of ideas?...I'm still not sure whether I would like to post my project as a web page or on Blackboard. I think I need to know a little more about Blackboard before I make that decision. Is anyone else interested in having a 2-hr workshop on Blackboard? Let me know?* (Nancy, email, March 23, 2001)

At our first whole group session, we agreed as a whole group to spend at least an hour every two weeks online in the discussion area. Teachers were told to keep track of their hours and after accumulating five hours, to take a release day as they wished. Collaborating in an online environment and participating in online discussions can be very time consuming and I did not want teachers to feel their online work was any less valued than their work face to face. All but one teacher participated in online discussions; however, not all teachers participated equally and not all teachers took release days in lieu of their time spent online.

In the beginning I initiated the discussion items and as teachers felt more comfortable with the online environment, they started new discussion threads. The number of postings and quality of the discussion items that teachers submitted over the next ten weeks surprised me. There were a total of 50 postings by teachers. Thirty-two messages were posted in the whole group discussion area and a total of 18 postings were made in the individual group discussion area. Each posting was typically at least one paragraph long but many were often whole pages. The quality and quantity of the responses surprised me, since five of the teachers in this project had no prior experience with posting messages in a chat area and for some it was initially a difficult and time consuming task. One teacher described what it was like for him to post messages:

> *I tried to collaborate online. I've gone to make messages and taken the time to send a response to questions, but I haven't got it to work. I've printed but it hasn't gone anywhere. People get frustrated with me. I've tried. I don't have the time right now. The night of the chat line, I had all intentions of going there. You have no idea what happens at home. Things get pushed aside, priorities take over and boom! It's not*

that I don't want to collaborate. If I was computer wise and I could find a slot, I could do this. (Ivan, interview, April 10, 2001)

Two teachers who had access to a networked computer in their classrooms were the most active participants in the online discussions. One of the teachers who had no networked computer in his classroom or a connection to the Internet at home made no online contributions. Another teacher, Steven, felt that if he had a networked computer in his classroom or if the one at home had a better connection to the Internet than a 14.4 K modem, he would definitely be able to participate more in an online environment. However, having a slow modem at home did not deter his participation in the online discussions. In fact, Steven was a regular contributor and shared his thoughts about technology in general, online communication and what these new technologies meant to him as a teacher. Examples of his postings include the following:

As an _____ teacher, I know that I have no choice but to respond to these new technologies. Even if I decide not to use computers, my students are using them outside of class. This dramatically changes the way I do my job. To paraphrase Neil Postman, we don't have the old school system plus computers. Everything adjusts to the new technology to create a completely new system... So my question is "What changes are you making due to students using computers outside of class and is there anything that you have noticed that others aren't paying attention to or aren't taking seriously?" (Steven, online discussion, May 16, 2001)

If we wish people to communicate effectively, for example, that needs to be modeled in person. There is so much that is not communicated through a computer screen.

Body language and tone of voice, and emphasis are just a few examples. As I am writing this I realize that we have to define what we mean by learning, and then the question becomes "What kind of learning happens best in a classroom and what kind of learning is better facilitated through networked technologies?" (Steven, online discussion, March 16, 2001)

Online Discussion Topics

Some of the discussion topics included how technology has changed what we do in the classroom, whether technology integration is worth all the expense and time and whether we need to do things differently in the classroom in order to make effective use of these new technologies. I have worked with some of these teachers for over 10 years at the same school and as I read their postings, I realized how little I knew about their teaching philosophy and approaches to teaching and learning. As colleagues, we had never taken the time nor had much opportunity to discuss our beliefs and approaches to teaching and learning. Leonard, for example, responded at length to other teachers' questions and ideas on the role of the teacher and what is effective learning:

I still am of the opinion that the most effective and efficient way to use the web is to have the proper equipment to display materials and web pages on the overhead with a so-called teacher centered approach. Even with interactive web material, the same learning outcomes could still be achieved even though the teacher has his finger on the tail of the mouse. With this approach the teachers are gaining ever more experience and *confidence. Only after this is done, by the majority of teachers would we have the 'net savvy to possibly take the net step to PBL or a more student centered approach.* (Leonard, online posting, April 4, 2001)

In the learning equation is it good leadership that is important or is it large followership [sic] *that we are after? Does one imply the other? I'm sure you don't need to be the sage to have learners lapping lustingly, the knowledge and wisdom from your palms. Isn't successful TEACHING or should I say LEARNING achieved when students are pining for the Pied Pipers ponderings?* (Leonard, online posting, May 5, 2001)

Teachers also discussed problem-based learning as an approach for making use of the networked technology in the school. Nancy posted a message in her group discussion area that shows how she was beginning to construct her understanding of the problem-based learning process:

just doing some reading and realizing that there's got to be lots of structure in this PBL thing in order for the students to experience true learning freedom. I'm a little skeptical about letting them run rampant with a 'problem' they are going to solve on their own but excited to begin finding a method that will make it all work. I'm trying to think of a problem I could present about the renaissance that could really produce some interesting stuff. Any ideas?? I found the article 'the problem-based learning process' the most helpful so far in providing direction. What about you guys?? (Nancy, email, March 31, 2001)

A week later, she responded to a member of her group and talked about how she might use PBL in her classroom:

I did some reading yesterday on PBL and although I definitely think I should be using this method in my classes, I don't think I'm going to use it as a model for my

project. I think it will be enough of a challenge to create the Internet inquiry on it's own. However, PBL has certainly given me a lot to think about! I'm going to try and design some more Socials lessons & units around a big question where students have more choice and work more independently. What are your thoughts? (Nancy, email, April 02, 2001)

On April 27, one of the teachers came to my room and felt that certain teachers were not participating online to warrant time off. We talked about the difficulties some teachers were having and that sometimes, brief messages posted by teachers did not necessarily mean that teachers were not participating fully. Reading other teachers' postings, thinking about them, and formulating a response can take much time. We also talked about how an online instructor needed to evaluate not just the quantity, but the quality of students' responses. I pointed out that we still had another six weeks and that the online discussions were helpful to my research study.

Reactions to the Ill-Structured Problem

At the start of this study, teachers were given an ill-structured problem. I had been working in this school as a Teacher Leader in technology integration for six months prior to this study and several teachers had expressed this very same problem to me. The problem that I gave participants was the following:

> The Internet has arrived in your classroom! You are feeling the pressure from administrators, parents and students to use this technology in your classroom. You would like to learn more about how to use the Internet for teaching and learning but are not sure how to go about it. You have been asked by your department to prepare

a brief oral report on some issue related to teaching with technology and create a web site with activities for students in your classroom.

One teacher in this study, however, did not feel the problem was authentic. He felt that the need to understand and integrate technology effectively was not a genuine problem but an option he could choose to ignore at this time in his teaching career. He wrote:

> *Integrating technology in my classroom is not really a problem for me. The problems for me I'm facing right now are getting my marking done, shuffling my time—I've got kids coming at me, I'm supposed to organize the stage crew for an assembly all over a 15 minute break. Integrating technology is in light of that is like step 184 down the list. No one is going to fire me— at this point it's not really a problem...They're not giving me the tools, no one is making me do it, no one is giving me the actual technology to use, so where's the problem?...In my life right now, it is not problematic. I need to deal with problems in my face. Authentic is something that in theory in an actual situation is problematic. If your job is on the line it could be a problem.* (Steven, interview, March 21, 2001)

Another teacher felt that the problem was authentic but not ill-structured:

> *This problem is not truly ill-structured but I would say it was authentic. The environment of the task is pretty predictable but helped us develop some really needed skills for technology integration.* (Evans, correspondence, April 19, 2001)

Evans, later in the study outlined how the problem helped him determine what to focus on and which direction to take:

> *The role this problem has played in my learning about technology integration:*

a. *It made me rethink about my own teaching*

b. *It prompted me to make choices about maintaining my traditional ways of delivering lessons or jump on the bandwagon of technology integration*

c. *I had to decide how far, how determined or committed I would be with regard to using technology integration*

d. *In order to solve this problem I had to start learning a little bit about using the technology and a great deal about the process of integrating technology with teaching* (Evans, correspondence, May 16, 2001)

Yet another teacher talked about the need for an authentic problem in problem-based learning that draws people together through a common need to find a solution.

> *If you* [anyone] *could come up with a problem that could apply--a life style problem that affects all of us- and that becomes where you can draw upon wisdom, you can draw upon the strengths of the computer enhanced person, I think if you* [anyone] *could create that type of problem, that would draw people together because they all do want the solution.* (Ivan, interview, April 10, 2001)

Participant Responses to PBL and Use in Their Own Practices

Throughout the study, teachers commented on the use of problem-based learning in their own classrooms. One teacher described how PBL fundamentally shifts what he expects students to do in the classroom:

> *After seven years in the classroom I've learned how I best want them to respond in certain situations, be it small group discussions, short answers writing a paragraph, taking a quiz etc...But this is all new territory. I really need to think through my*

objectives and how to meet them. I told Maryjanne yesterday that its like I'm being asked to teach science all of a sudden. (Steven, correspondence, May 16, 2001)

Another teacher described some of the typical benefits of working collaboratively on a shared problem and that being exposed to PBL through this project has made him think about problem-based learning itself:

I learned how to structure an ill-structured problem and how to relate problems encountered in the past to the contemporary world. We as a group taught and learned from each other. We constantly fine-tuned what worked and what did not work and strategized for improvements. Once the final product is produced, myths about using technology integration can be demystified and hopefully, more people will come on board. (Evans, correspondence, May 16, 2001)

Leonard maintained his strong beliefs about the use of technology as tools for teacher to deliver content throughout this project, but he has begun to think about how PBL might be used in his classes:

It got us talking about teaching and learning and best practices and how to make effective use of technologies. The training was great. I've learned some things- it makes you think about the possibility of how PBL works...I might try PBL stuff in a general math course next year and experiment with it...I can see that PBL may be more effective in some courses than others. (Leonard, interview, June 15, 2001)

At the end of the study Irene wrote that she saw how PBL and co-operative learning were related and that if she returned to a classroom setting, she would definitely use a problem-based approach:

I learned that PBL is very much related to co-operative learning and whole language learning...I would use PBL in a minute if I ever returned to the classroom. My entire classroom was based on whole language, co-operative learning—I love it and so do students. (Irene, email, June 27, 2001)

Summary

In this chapter I described some of the recurring themes found in the results of the data collected from seven high school teachers' experiences with problem-based learning as a model for professional development in technology integration. I used data from interviews, pre- and post-questionnaires, email and other writings of participants. I also noted and included my own observations, thoughts, and feelings throughout this chapter.

The participants in my study were all teachers working full time in an urban high school. Three teachers had more than 20 years teaching experience; two teachers had between 11 and 19 years and two teachers had less than 10 years. Three of the seven teachers had some previous experience with problem-based learning and five of the seven had limited experience with computer technology as a tool for curriculum integration.

From the collected data, I identified common experiences teachers had with problem-based learning as a model for in-service training in technology integration. In general, the teachers all responded favourably to the project and all felt that their skills in computer use and understanding of technology integration had improved. However, three teachers felt that the quality of the problem needed to be improved in order for teachers to engage more fully in the problem-based learning process. Collaboration among teachers was also problematic for some teachers. At times, the teachers felt

frustrated by the group process and preferred to have more direct instruction from myself as the facilitator.

The use of computer mediated conferencing software to provide opportunities for teachers to engage in discussion and collaboration gave some surprising results. All teachers except for one, participated in online discussions and there was a total of 50 postings by teachers not including my own postings. Even the teachers with limited computer skills took advantage of this opportunity and used the online software to explore with other teachers ideas about teaching and using technology in their practices.

CHAPTER FIVE

DISCUSSION OF THE RESULTS

The purpose of this study was to examine the use and possibilities problem-based learning offered as a context for teachers to learn about and teach with networked technologies. My main objective was to describe the experiences of teachers in a secondary school as they engaged in a problem-based learning project that focused on learning how to integrate networked technologies into the classroom.

Seven teachers from an urban high school participated in this study over a 3 1/2-month period during the school year. These teachers were given a total of eight release days and I worked with these teachers as their PBL facilitator.

Results from my study indicated that overall teachers valued and felt they had benefited from the learning opportunities a problem-based learning model provided. These opportunities included support over time, purposeful work, and time for discussion and reflection with their peers.

However, results from my study also revealed certain challenges these teachers encountered as they worked together through the problem-based learning process. The results from responses from some of the teachers on the nature of the problem that was presented to them support findings in the literature that problems in problem-based learning need to be authentic and owned by the participants. Furthermore, as the literature also indicated, providing opportunities for collaboration does not necessarily mean that effective collaboration will occur. Results from my study reveal some of the difficulties these teachers experienced as they worked as a group to address the problem that was presented to them.

Lastly, in my study, teachers took advantage of the flexibility that computer mediated conferencing software offered as they dialogued with each other using a courseware program called Blackboard. Their experiences support findings in the literature that an online environment can provide opportunities for reflection, discussion and collaboration.

PBL and Effective Teacher Professional Development in Technology Integration

The teachers in this study reported that overall their computer skills and understanding of technology integration issues improved. One teacher wrote:

> *All in all I do think I learned a lot...I have a little web page going; I know how to do the links, and I am more clear on my needs for special ed. I know what good Internet assignments can look like. I'm clear on the need for a technology plan* [for her department] *that goes way beyond the fact we need more machines* (Irene, journal, April 20, 2001).

Other teachers gave similar comments to me both in writing and in casual conversations. Leonard, during a final interview said, "*These sessions and this group training were great. I've learned new things and it makes you think about the possibility of how PBL works and if it works in my subject or not*" (interview, June 15, 2001).

Changes in teachers' self-perceptions of their understanding and knowledge of technology integration were also reflected in the changes in their pre-and post-questionnaire responses. It is important to note that the questionnaire was not intended to be used as a measure of the effectiveness of problem-based learning to train teachers about technology integration. The purpose of this questionnaire was simply to note if there were any changes in the teachers' perceptions about their abilities as a result of their

participation in this study. These changes in the teachers' self-perceptions may not necessarily be attributed to the problem-based learning model used to train these teachers. In fact, these changes were not surprising to me since each teacher spent a minimum of 15 hours of hands-on work on networked computers. They used email, learned how to search and subscribe to educational listservs, find other teaching resources, and build web pages. Some of the changes may have been the result of the direct instruction that I sometimes gave participants and perhaps some participants rated themselves as they did as a way to show their appreciation of my efforts.

However, some of the contributing factors for teachers' changes in perception and engagement in this study may have been the result of the learning conditions or learning context created by a problem-based learning environment, which Bridges (1992) describes as authentic and functional. The teachers came together to work on a problem that addressed the concern for more effective use of technology in classrooms. The problem gave the teachers a focus and the PBL process gave teachers the opportunity to work together, share ideas and support each other. Computer skills were acquired and knowledge of technology integration was constructed as teachers worked on a project that for most of them was personally meaningful to their teaching contexts.

Another feature of problem-based learning which the literature reports is a necessary condition for effective professional development in technology integration is the support for teachers over time (Fisher et al., 1997; Schumaker & Clark, 1990). An extended time frame characteristic of problem-based learning builds in opportunities for teachers to plan, revise, and reflect on the issues and not just learn technology tools. This on-going support was noted and appreciated by all teachers and expressed by Ivan when he said,

"Having this amount of time and someone on staff to support or mentor us gets us learning more than how to use the technology" (hallway encounter, May 24, 2001).

Teachers in this project saw the value of group collaboration and some teachers wanted to continue to support each other as a group and create a network of teachers in the school interested in technology integration:

> *To keep learning on a long-term basis, we should maintain a core-interest group to keep learning and practicing, and the core group will carry the torch in embracing new learners to participate in the project. In our future endeavors, new topics can and will be brought forth to make web designing less intimidating, and more collegially, staff across departments will communicate and more sharing will take place.* (Evans, online discussion, April 20, 2001)

Irene responded with the following:

> *I just wanted to take a minute and tell you* [Evans] *that I think your vision of this projected continuing as a core group and embracing others as time goes on is awesome.* (online discussion, May 19, 2001)

Furthermore, as supported in the literature, problem-based learning did seem to have a positive effect on the participants' motivation and attitudes in this study. Research studies show that students in problem-based learning programs have more positive attitudes than students in traditional programs and there is evidence of increased motivation (Bridges, 1992; Ryan, 1997; Woods, 1991). In my study, most teachers remained keen throughout this project and reported positive attitudes towards learning about technology and its use in the classroom. One teacher wrote,"*Thanks for all your help. It has been a worthwhile project. I can't possibly retire now!!* [sic]" (Leonard,

correspondence, June 19, 2001). Another teacher who had trouble fitting in all the group sessions, nonetheless found the process a positive and purposeful one:

> *This has been very enlightening. I have been unable because of all the field trips to fully take advantage of what has been offered. The last session was a turning point because many of the assets I previously learned have started to make sense; I also have come up with an application.* (Aaron, correspondence, May 17, 2001)

One of the secondary purposes on this project was to determine if using problem-based learning as a professional development model would have any effect on teachers' instructional beliefs and confidence in implementing problem-based learning in the classroom. Sage and Torp (1997) argue that "using PBL to *teach* [sic] PBL is essential, so that teachers experience as learners first" (p. 88). Teachers who began this study with limited or no knowledge of PBL felt that PBL was something they would be willing to explore further in their classroom practices:

> *PBL has certainly given me a lot to think about! I'm going to try and design some more socials lessons & units around a big question where students have more choice and work more independently.* (Nancy, email, April 2, 2001)

At the end of the study, another teacher said, "*I might try PBL stuff in general math courses next year. I'd like to experiment with it*" (Leonard, interview, June15, 2001).

Quality of the Problem in Problem-based Learning

The importance of the quality of the problem in the problem-based learning process has been noted in the literature. Effective problems that promote meaningful learning experiences are authentic, complex, open-ended and ill-structured (Barrows, 1986; Hmelo & Evensen, 2000; Hmelo & Ferrai, 1997).

The teachers in this study were asked to come up with some learning activity and some understanding of the issues in effective technology integration in the problem that was presented to them. The problem had no standard solution and no single best answer. As a Teacher Leader in Technology Integration at the school, I used my prior experiences working with teachers on technology integration to frame the problem which I felt was an authentic problem that teachers today are experiencing in schools. Teachers are feeling the pressure from administrators, parents, and students to use networked technologies that are available to them. Every teacher has a classroom drop to the Internet, and access to a multi-purpose lab and library computers in the school where the study was conducted. Many teachers are not sure how to go about designing learning activities that utilize these technologies.

Teachers in my study often gave this as a reason for joining this project as reported in the results. One teacher commented:

> *I need to learn more about how to use computers in my teaching... The students know more than me and I need to know how to get them to think with this technology.* (Ivan, hallway conversation, March 13, 2001)

Another teacher in the study said:

> *I know the technology's there but I can't get around to doing anything with it. I'd like to--don't get me wrong, but there just isn't enough time to learn it.* (Aaron, hallway conversation, March 7, 2001)

However not all teachers connected with the problem in a personally meaningful way. In my study, three teachers out of the seven, felt that either the problem was not

really a problem or it was not ill-structured enough. One teacher in an online discussion wrote:

> *When it [PBL] has worked for me...is when there is a real motive to solve the problem. There seems to be something missing here. There is no pressing need to solve the problem. The problem is phrased in such a way that it is not really that problematic. It sounds more like an assignment.* (Steven, online posting, April 13, 2001)

How the quality of the problem in this study affected the learning outcomes of the teachers was beyond the scope of this study. However no doubt as the literature suggests, learners in PBL must see the value and relevance of the problem if they are to become engaged in the learning activities (Savery & Duffy, 1995). It makes sense that the closer the problem is to the daily lives of teachers perhaps the more likely they will be motivated to collaborate and invest time and energy into solving the problem. Perhaps in order to ensure a problem-based learning model is effective as a professional development model, the problem needs to be solicited by the teachers themselves. As the literature on effective professional development revealed, when the need for improvement of practice is generated by teachers who define their own problems the outcomes are more successful (Bridges, 1992; Eaker et al., 1992; Harris, 1993; Williams & Williams, 1994).

Collaboration

As noted in the literature, ill-structured problems promote the necessity for learner cooperation with others in order to find effectively some solution to the problem (Duch, 1999). However, Hmelo and Evensen (2000) warn that simply providing the right kind of

problem that promotes student collaboration does not necessarily mean that effective collaboration will happen:

> One particular danger...is the assumption that the journey from problem to learning outcome is uncomplicated or that given a compelling problem, students will naturally want to work together to solve it. (p. xi)

This was certainly evident in the results of my study. Some teachers experienced difficulties collaborating with other teachers in this study and not all teachers participated equally in the group process. Some teachers found it difficult to schedule meeting times where all group members could be present. Other situational and dispositional factors such as teacher personality conflicts also made group negotiation among teachers more difficult.

As the model of causal paths in PBL in the literature review indicates, effective group functioning may depend on the quality of the problem and amount of prior knowledge (Schmidt & Moust, 2000). Teachers in this project came with a wide range of computer skills and knowledge of problem-based learning as a model for teaching and learning. Teachers with limited computer experience were more dependent on other teachers and myself to acquire basic skills than were other teachers in the group. In an online discussion, Ivan posted a message on what he felt his needs were:

> *What* [Aaron] *and I need are skills development. For example, do you know how long it took to figure out how to send this message?* (online posting, March 28, 2001)

Later, in an interview, he felt his group was having trouble working effectively because the group members' needs were too diverse. He understood why some teachers who had stronger computer skills were not very willing to take the time to help him out with basic

skills acquisition. While not all teachers were always willing to provide effective help for others in computer acquisition skills, some teachers almost always encouraged others, and engaged in positive interactions. As noted in the literature review, positive interdependence is a critical ingredient for successful group collaboration (Johnson et al., 1994). Maintaining and encouraging positive interdependence was an ongoing challenge in my project given the diverse needs and pressures on teachers who had limited time to achieve a purposeful project they could use in their classrooms.

Furthermore, because teachers in this study did not teach within the same content area, it was more difficult for some teachers in the study to collaborate on the problem with other teachers and produce some learning activity that could be shared by other teachers in the group. When Marx et al., (1997) reported in their study on the need for teachers to collaborate and reflect on what they do in class with their peers in order to build collegiality, their results were based on a group of science teachers in the same school. Because teachers in my study taught in several different disciplines, it was more difficult to build the kind of purposeful collegiality described by Marx et al. Thus, some teachers did some of their work independently from the other teachers. This also reflects one of the characteristics as reported in the literature of adult learners who are more interested in practical and just-in-time relevance to their own immediate needs (Cravener, 1998; Manning et al., 1994; Wilkerson & Hundert, 1991). The educational research community is beginning to examine the relationship between group dynamics and self-directed learning and how both interact in social learning (Hmelo & Evenson, 2000).

Problem-based Facilitator

As described in much of the literature, the problem-based learning facilitator faces many challenges and can have a major influence on the success of the problem-based learning experience of learners (Hmelo & Evenson, 2000). I certainly found this to be true in my own experiences as facilitator in this study.

One of the challenges I encountered was creating a climate where teachers effectively collaborated with other teachers. At the beginning of the study, I naively assumed that once teachers were given a problem that required some group interdependence in order to solve it, collaboration would occur naturally. All I had to do was step back, and let teachers decide how to proceed. However, I soon realised that there were many factors at play in the group processing of the teachers in my study and that I would need to intervene. Teachers were having trouble coming to any consensus on how to proceed and some teachers felt that they needed some direct instruction with computer skills acquisition. A few teachers approached me personally to intervene or to give them some more direction.

I struggled with how much intervention and when. I was always conscious of how little time teachers had to devote to anything over and above their working days and I did not want teachers to feel frustrated. Torp and Sage (1998) note that, "The big decision in each teaching moment...is deciding when to let the players play and when and how to intervene" (p. 67).

It was very easy for me to step in and direct the learning activities of the group. After all, I have been directing students' learning experiences as a teacher for almost 16 years. After our third group session as I reflected back on the day, I realised that

however unintentional, I had taken ownership of the group and the problem and that most members of the group were very happy that I had done so. The teachers in my project were also used to a teaching model where the teacher as expert delivers content information and structures the learning environment.

But I also think that those teachers who had little or no computer skills perhaps needed more direct instruction, at least initially. The teachers in my study who had minimal computer skills focused much of their time on learning basic computer skills. However, once these teachers felt more comfortable with using the technology, they became active participants in online discussions on the pedagogical issues of technology integration. It did not take long for example, for some of these teachers to make effective use of the computer conferencing software in Blackboard. They posted questions and responded to other teachers' ideas. Can teachers participate in effective practice in technology integration without feeling comfortable using the technology themselves? Clearly, this is an area for further research.

Collaboration and Computer Mediated Conferencing

Results from the use of computer mediated conferencing software in this study also supported some of the claims in the literature on the ability of this technology to support conversation and collaboration (Hiltz, 1990; Jonassen et al., 1995; Murphy et al., 1996; Savery & Duffy, 1995). Teachers in this study collaborated online and engaged in thoughtful discussions that were difficult to do face-to-face given the busy lives of these teachers. In this time-independent environment, teachers were able to take advantage of this flexibility to discuss issues relating to teaching with technology in an on-going way and with depth. As reported in the results, one teacher in the study was able to continue

participating in group discussions even though she had to leave the province for a short period of time.

This supports findings in the literature in studies by Harasim (1990) and Bates (1995) that time-independent collaboration may serve group members' need for greater flexibility for participation in collaborative activities. However, group formation may take longer and co-ordinating tasks may be problematic in an asynchronous environment especially when group members have different expectations of how often and when to log on (Abrami & Bures, 1996). This was certainly an issue for some teachers in my project who felt that not all members were contributing equally to the online discussions.

Bates (1995) reports that researchers have noted that interaction in computer conferencing environment can enhance cognitive and metacognitive skills and that the threaded discussion items provide more possibility for reflective analysis (Kaye, 1991). While my study did not look specifically at the effects of online collaboration on group participation nor did I attempt to evaluate the asynchronous text-based collaboration in any systematic way, the findings of teachers' postings in the online discussion show thoughtful analysis of the issues being discussed. The model for evaluation suggested by Gundawarda and Lowe (1997) as described in the literature review was useful to examine the nature of some of the online interactions. There was evidence of Phases 1, 2 and 3 of this model that included sharing and comparing of information; discovery of dissonance and inconsistency; and negotiation of meaning. There was no evidence of the other phases. These other phases described by Gundawarda and Lowe are testing and modification of proposed synthesis and agreement and application of newly constructed

meaning. The following is a sample of an online exchange on the need to do things differently in the classroom that shows the first three phases:

> *The Conference Board of Canada (1991) outlined new skills needed in the workforce...My question is what teaching/learning approach and strategies prepares students for these new demands? Has the time come to bury the sage on the stage?* (Maryjanne, online posting, April 29, 2001)

> *The sage in the stage has come of age, provided you are on the right page. Isn't it ironic that some are preparing for his funeral while many others spend a lifetime trying to become him? I think students need to observe strong leadership as role models from which to mound their own identities and personalities as they are growing into adulthood. Theoretically it all sounds very sexy—ability to learn independently—ability to adapt to changing circumstances—thinking skills etc. I think mathematical problem solving addresses many of these points (learning how to think). Many people generally not only young people, are lost when it comes to helping themselves. The PBL approach is very much of a help yourself approach to learning. How effective and efficient is it? What are YOUUUUUU thinking?* (Leonard, online posting, May 1, 2001)

> *In many circumstances, the sage on the stage model doesn't work effectively. And I agree with the list of posted skills that today's students will need. Yet, it doesn't follow that students need computer technology to acquire those skills, nor that teachers need them to get off the stage. Perhaps what the computers give us is a new*

context in which many new situations become possible. They give us a chance to see our subject afresh...I know that [Leonard] *stated that students pick up many of those skills in math class, so here comes by bias: I teach all those skills every day in my English classes...but perhaps computers are only one tool to achieve the necessary change and to reconfigure the learning environment so that it eliminates the stage.* (Steven, online posting, May 3, 2001)

Well said, you all have very valid points. I think that the classroom should be a mixture of the sage on the stage and the self-directed learner. (Glenda, online posting, May 6, 2001)

I agree with you [Glenda], *usually the answer lies somewhere in between two polemical points of view.* (Irene, online posting, May 21, 2001)

Although I had worked with some of these teachers for several years and had attended many of the same meetings and professional development sessions, I learned much about these teachers' beliefs and approaches to teaching and learning though these online discussions. Teachers do not often have the time to come together with other teachers to reflect on practice, on values, and on personal philosophies. We are so isolated from each other in our classrooms that we rarely have opportunities to engage in sustained dialogues about our professional practice.

Implications

From my study, I have learned that a problem-based learning model can provide positive professional development experiences for teachers in technology integration. Teachers in my study valued and benefited from the learning opportunities this model

provided particularly the support over time, purposeful work, and time for discussion and reflection with their peers.

However, results from my study also suggest that for PBL to be a more effective model for teacher professional development, it may need to be adapted to meet the specific needs of teachers and the context in which they work. These adaptations include the following:

1. So that teachers can develop some kind of ownership to the problem in problem-based learning, it may be important to solicit problems from the teachers themselves. This should be done through dialogue with teachers prior to using this model. This would give teachers a greater sense of ownership of the problem, take into account their prior experiences and knowledge of technology integration, and give teachers a greater voice in addressing their own perceived needs.
2. Some of the problems with the teachers' group processing may have been due to a lack of prior discussion on the role and purpose of group collaboration in problem-based learning. In one study on assessing group processing, researchers concluded that the way members of a group participate is related to the type of group they wish to have (Faidley, Salisbury-Glennon, Glen & Hmelo, 2000). They suggest that facilitators assess whether learners' notions of engaging in PBL concurs with the facilitators' and that some prior sessions on these issues occur prior to using this approach. Therefore it should be considered important to provide an extensive overview of the problem-based learning process as a way to orient teachers to this model.

3. Furthermore, in order to create a climate of positive interdependence, the make up of the PBL group should be more homogeneous in terms of the teaching disciplines of the teachers. I found that teachers seem to find collaboration among members of their own department or discipline more purposeful; they can share common experiences, lesson plans and activities and express common needs.

My research provided me with mixed indications of whether a PBL model can address the varying needs and levels of technical expertise of technology. On the one hand, teachers with limited expertise felt compelled to learn basic technology skills before they could address the problem that was given to them. Learning how to use the technology became a primary goal for these teachers. On the other hand, it did not take long for these teachers to acquire the skills that enabled them to tackle the problem. Meanwhile, teachers with more expertise worked more independently and sometimes felt hindered by the needs of the other less computer savvy teachers. Having groups of teachers with mixed technical expertise did present some problems with group collaboration. Being able to sort out these problems seemed to depend on the dispositional factors of the teachers. Again, teachers should be given the opportunity to define the group they wish to have in order to make their participation more purposeful and collaboration more effective.

Although teachers found collaborating in an online environment somewhat of a novelty which no doubt played a role in their interest in this tool, the potential of online learning communities to support problem-based learning collaboration among teachers is very exciting. Online conferencing should be used more in teacher professional development programs. Interactivity, dialogue, collaboration, and reflection are all

elements possible in a networked learning environment which should be exploited more fully in teacher professional collaboration. More research is needed in the role asynchronous text-based discussions play in the group processing in problem-based learning.

Conclusion

The reason this study was undertaken was to discover and examine teachers' responses to the use of a problem-based learning model for professional development in technology integration into the classroom. The teachers in this study were given eight release days from their regular teaching duties to participate in this study and these days were used over a 3 1/2 month period between March and June, 2001.

In this case study, the teachers' responses to the features of problem-based learning such as the ill-structured problem, the collaborative process, and the role of the PBL facilitator were some of the recurring themes that I discovered. By using a case study approach, I was able to illustrate some of the complexities of the teachers' experiences with PBL in a particular context. However, as with the case study approach, generalisations about the efficacy of PBL as a model for teacher professional development are not possible given the contextual nature of this study.

This study does support claims in the literature that collaboration within a PBL framework is a complex process affected by many factors such as the quality of the problem, the extent to which the collaborative goals of the participants are shared, and other situational and dispositional factors. Furthermore, the results of this study also indicate that a PBL model can provide the necessary conditions for effective teacher professional development as reported in the literature. The teachers in the study

appreciated the on-going support over time, purposeful collaboration with others, and work on a project that was personally meaningful to them.

Because the focus of this study was on teachers' experiences with problem-based learning as a model for professional development in technology integration, I did not include any analysis of their final solutions to the problem. What were germane to this study were teachers' responses to the process of problem-based learning. After the study was concluded, several teachers decided to show what they had produced to other teachers in the school. Three teachers had created web pages that included resources, course outlines and other learning aids for their students. These teachers uploaded their pages onto the school server. Three teachers created lesson activities with links to Internet resources. These lessons were also created as web pages. One of these teachers actually implemented the lesson into his class before the school year ended. Although not the subject of this study, research into studying teachers' finished solutions or projects as a result of using a problem-based learning model for professional development may give further insight into the use of this model.

It is clear to me that this study posed more questions than answers. Did teachers' self- perceptions of improved computer skills and understanding of technology integration change as a direct result of the learning advantage of problem-based learning or because they had ongoing direct support and instruction? Did the difficulties with group collaboration have anything to do with PBL itself? Would PBL as a model for training teachers in technology integration work differently with groups comprised largely of novice technology users or advanced users of technology? Clearly, there is need for further study in the use of PBL in teacher professional development in

technology integration. This study suggests that this model is worthy of serious consideration by institutions and individuals responsible for training teachers in technology integration.

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of Research Studies at the University of British Columbia, Dr. Richard Spratley at 822-8598.

Consent:
Please indicate your consent or refusal to participate in this study by completing the attached forms (pages 3 and 4). Please keep this description of the study (pages 1 and 2) and one signed copy of the consent form (page 3) for your records. Please return the other copy of the consent form (page 4) to me as soon as possible. Thank you.

Using a Problem-based Learning Model for In-service Teacher Training in Networked Technologies

Prospective Teacher Informed Consent Form

I (*please print*_____ have received a copy of the consent form describing the study called "Using a Problem-based Learning Model for In-Service Teacher Training in Networked Technologies". I have read the consent form and have signed both copies of the form. I will keep one for my own records and return the other to the investigator.

Signature _____

I **agree** to participate in the study titled " Using a Problem-based Learning Model for In-Service Teacher Training in Networked Technologies" in the following ways:

Please check all that apply

[ ] I give permission for copies of my work (related to the project) to be used as part of the data for the study with the understanding that confidentiality will be assured.

[ ] I volunteer to participate in the interviews during the study (2 interviews of 15 to 25 minutes each.

[ ] I volunteer to answer a pre and post self-administered questionnaire .

I understand that in any written reports or publications my identity will be disguised and that confidentiality will be assured through the use of pseudonyms. I also understand that my work connected with this project will only be used for research and educational purposes.

Signature _____ Date_____

Your phone number _____

Please KEEP THIS COPY for your records.
Thank you for your time and consideration.

Using a Problem-based Learning Model for In-service Teacher Training in Networked Technologies

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I (*please print*_____ have received a copy of the consent form describing the study called "Using a Problem-based Learning Model for In-Service Teacher Training in Networked Technologies". I have read the consent form and have signed both copies of the form. I will keep one for my own records and return the other to the investigator.

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I understand that in any written reports or publications my identity will be disguised and that confidentiality will be assured through the use of pseudonyms. I also understand that my work connected with this project will only be used for research and educational purposes.

Signature _____ Date_____

Your phone number _____

Possible "good" times/days that you would be available for an interview:_____

_____

Please <u>RETURN THIS COPY</u> to Maryjanne Yusyp as soon as possible. Thank you for your time and consideration.

APPENDIX B

INTERVIEW QUESTIONS

Using a Problem- Based Learning Model for In-service Teacher Training in Networked Technologies

Interview Questions

Interviews will be conducted at different times throughout this study and with each participant. Interviewees will be given the option of not answering any question that they do not wish to answer. The following questions will be asked at different interview sessions and some questions will be repeated at these sessions.

- Why did you volunteer to participate in this study?
- What are your concerns or questions regarding the integration of technology into the classroom?
- What do you think we should be doing with computers in the classroom?
- What problems have you had if any in using networked technologies in your classroom?
- What prior training experiences have you had in the use of technology in the classroom?
- What kinds of training in the use of technology and its application in the classroom have you found effective and ineffective?
- Describe your approach to the teaching-learning process and how does the use of technology fit in with your approach?
- What are your thoughts, feelings and responses to problem-based learning?
- What important experiences have occurred for you during this project?
- How would you evaluate using a problem-based learning model as a way to integrate networked technologies into the classroom? Do you consider this an effective or ineffective model of technology integration in your classroom?
- What have you learned from participating in this study that will assist you in technology integration?

- Has being involved in a problem-based learning experience changed you as a teacher?
- Do you feel you know enough about networked technologies to make effective use of them in your classroom?
- What do you plan to be doing with networked technologies in your classroom in the future?
- We are at the end of the interview. Is there anything else you would like to comment on or add?

_____ Level 2: I understand the concept of e-mail and can explain some administrative and educational uses for it.

_____ Level 3: I can use the e-mail services of the Internet to read and delete messages; send, forward, and reply to messages to accounts in both the same and different domains; interpret domain names (i.e., "gov" or "edu").

_____ Level 4: I can create distribution lists, send group mailings and modify message headers. I can create and use nicknames and/or an electronic e-mail address book. I can file and retrieve messages for later use. I can print messages. I check my e-mail at least once a day, and return messages promptly. I use an appropriate e-mail signature. I use e-mail to communicate regularly with other educators or individuals in an effort to improve my teaching and my students' learning. I use e-mail to collaborate with others.

III. Listservs

_____ Level 1: I have no knowledge of listservs.

_____ Level 2: I know what listservs are and how they work; however, I do not personally subscribe to any listservs.

_____ Level 3: I can locate appropriate listservs, subscribe to and unsubscribe from a listserv.

_____ Level 4: I contribute to one or more listservs and post messages and replies to the list. I know how to temporarily suspend delivery of messages from the listserv and to resume delivery.
I know how to access and use listserv archives if they are available.

IV. Newsgroups

_____ Level 1: I have no knowledge of newsgroups.

_____ Level 2: I can locate the newsgroups available from my account, and can read newsgroups.

_____ Level 3: I understand the organization of newsgroups and can navigate easily through them. I read several newsgroups that interest me on a regular basis..

_____ Level 4: I can contribute to newsgroup and help others find newsgroups that may be useful and interesting to them.

V. World-Wide Web

_____ Level 1: I do not understand what the World Wide Web is.

_____ Level 2: I can navigate through the World Wide Web. I understand what a URL is and can enter one in the proper location to access a specific server.

_____ Level 3: I use the World Wide Web and can explain the meaning of hypertext, http, and html. I can explain what browser utilities are used for and why they are helpful. I can discuss the differences between a World Wide Web server and a World Wide Web browser. I can name several. I can access a directory listing such as Yahoo.

_____ Level 4: I can locate and access subject specific information using a World Wide Web search engine. I can access the html source and save the text and gifs for a specific World Wide Web page. I can list and use at least two World Wide Web browsers.

VI. Evaluating Internet-Based Information:

_____ Level 1: I do not know anything about the evaluating Internet-based information.

_____ Level 2: I understand that there may be problems with Internet-based information but I am unclear about it.

_____ Level 3: I can identify, demonstrate problems related to accuracy, authority, objectivity, currency and coverage of information from Internet-based and always evaluate the resources I find before using them.

_____ Level 4: I can find and list Web sites that contain helpful information about evaluating Internet resources and I instruct my students how to check the accuracy, authority, objectivity, currency and coverage of Internet resources. I provide them with guidelines or checklists for evaluating these resources when they use the Internet.

VII. Organizing Internet Resources for Personal and Professional Use

_____ Level 1: I cannot identify any ways to organize resources.

_____ Level 2: I understand bookmarks, know how to bookmark sites, and use bookmarks occasionally.

_____ Level 3: I use bookmarks and organize them into subdirectories, check links regularly to be sure they are still active and accurate, delete unused bookmarks. I know how to export bookmarks to disk.

_____ Level 4: I use additional ways to organize and access resources for my personal and professional use including cutting and pasting URLs into word processing documents and databases or creating personal menu pages with links to frequently used sites.

VIII. Teaching and Learning about the Internet

_____ Level 1: I cannot identify any need for teaching my students for having them learn about the Internet.

_____ Level 2: I understand that the Internet may be a valuable resource for students and that information skills are important; however, I personally do not teach students how to locate or use Internet resources.

_____ Level 3: I use tutorials, books and Internet resources to learn about the Internet and to teach students about the Internet. I teach students techniques for finding, evaluating, and using information from the Internet. I teach them how to use search engines, how to navigate through materials, how to save and print information.

_____ Level 4: I teach students when the Internet may be an appropriate resource and when it may not be as useful. I help them to use, adapt, and integrate resources and information they find on the Internet and from other sources to answer a question, to complete an assignment, or to
create a report. I show them how to evaluate their work. When I create instructional materials,
I use Internet resources whenever appropriate. I cannot imagine teaching without access to the Internet.

IX. Using Internet Resources in Instruction

_____ Level 1: I cannot identify any use for Internet resources in my classroom.

_____ Level 2: I understand there may be some good information sources for me and my students, but I don't use them in my instruction.

_____ Level 3: I regularly look for Internet information re-sources which may be appropriate for my classroom and help students access and using them to reach instructional goals. I develop clear objectives and directions for the use of these resources and organize my classroom to take best advantage of the access and resources we have.

_____ Level 4: I create curriculum pages and online activities as an essential part of my instruction.

X. Participation in Telecommunication Projects

_____ Level 1: I cannot identify any telecommunication projects or the role they would play in my classroom.

_____ Level 2: I am aware of different kinds of telecommunications projects and the benefit they bring to students, but I do not use them in my classroom.

_____ Level 3: I regularly involve my students in telecommunications projects. I know where to find information about new and ongoing telecommunication projects, how to sign up and how to participate. I complete projects we begin.

_____ Level 4: I use a wide variety of telecommunication projects in my classroom ranging from keypal projects to collaborative worldwide projects. I state objectives for the project clearly, and evaluate my students on their ability to accomplish the objectives. I subscribe to a listserv or newsgroup that provides information about new and ongoing projects. I have or have considered creating and hosting such a project. I would find it very difficult to teach without using telecommunication projects.

XI. Utilizing Internet Resources in Instructional Materials and Student Projects

_____ Level 1: I am not aware of any Internet resources that can be used in creating instructional materials or student reports.

_____ Level 2: I know that resources from the Internet can be used in my instructional materials and my student's reports, but I do not use them or teach my students to use them.

_____ Level 3: I can locate appropriate information in a variety of formats (text, graphics, movies, and sound) on the Internet. I retrieve materials and use them in creating instructional materials such as transparencies, web pages, handouts, collaborative/ cooperative projects, centers, or multimedia presentations. I teach my students to do the same and expect them to use the resources in their reports and projects.

_____ Level 4: I can find resources in a variety of formats from the Internet. I know how to find and use software that will convert them to usable file formats if necessary. I provide checklists for my students to use in creating projects and reports, which include the need for Internet resources. They can use these resources independently.

This questionnaire has been borrowed and modified with permission from Drs. D. Baumbach and M. Bird, University of Central Florida.

APPENDIX D

PROJECT FRAMEWORK

Problem- Based Learning Project for Training Teachers to Learn About and Use Networked Technologies in the Classroom

1. Introduction

Schools across North America are being equipped with new computers and networked technologies yet with minimal attention given to staff training in learning how to make pedagogical use of these technologies. The Ministry of Education in British Columbia for example, reported having spent $179 million dollars from 1995-2004 to equip public schools with hardware and software in order to develop an infrastructure to support information communications technology use in schools. Yet only $11 million from 1995-2000 has been spent on teacher training. In a recent New York Times article, it was reported that although 95% of American schools have Internet access, 61% of teachers consider themselves "somewhat prepared" or "not at all prepared" to integrate the technology into their classrooms (New York Times July 3, 2000). Statistics Canada in a report released in 1999, titled "Computer Use in Schools" noted that one of the biggest obstacles to greater computer use in schools was lack of training opportunities for teachers.

The Canadian Alliance of Education and Training Organizations prepared a report in 1995 titled "Professional Development and Learning Technologies" and identified professional development objectives and best practices in schools:

> the key objective for teachers is to help students learn more effectively. To that end, professional development activities should emphasize how technologies can help teachers in this regard. Other more general professional development objectives are to: offer meaningful and creative experiences; help teachers believe they can do it; develop collaborative models and confidence; provide modeling and mentoring; and foster dialogue on the purpose of teaching and the roles of learning technologies in teaching.
>
> To be successful, the professional development experience has to be real; relevant, connected and applicable. The technology must also be used properly; proper use is indeed a key criterion for best practice. Teachers need to be taught in new ways, using new technologies. They can then apply those lessons in their own classrooms (p. 32).

The above recommendations for teacher centered professional development in technology integration provide the backdrop for this problem-based learning project. In this project, teachers will actively engage in and construct their own knowledge of technology use in the classroom. Through discourse within a learning community of other teachers, reflection and purposeful and authentic activity, teachers will experience an approach to learning and using technology that can be applied to their own classrooms. The following framework is one format of many used by educators to structure the problem-based learning process.

1. The Problem

The Internet has arrived in your classroom! You are feeling the pressure from administrators, parents and students to use this technology in your classroom. You would like to learn more about how to use the Internet for teaching and learning but are not sure how to go about it. You have been asked by your department to prepare a brief oral report on some issue related to teaching with technology and create a web site with activities for students in your classroom.

2. Learning Objectives

- dialogue and debate on the values, nature and objectives of the teaching/learning process and the role(s) of learning technologies
- learn simple web authoring skills
- create an Internet Workshop unit that can be used in your classroom to integrate reading, writing, content information and the Internet

1. Resources

- Facilitator - Maryjanne Yusyp
- Computer lab
- Netscape Navigator
- Reference and reading materials supplied as requested. You will be provided with support and reading materials for your group but you are encouraged to bring to your group whatever resources exist within your group such as prior knowledge, firsthand experience etc.

  * Highly recommended:
    Donald Leu and Deborah Leu. *Teaching with the Internet: Lessons from the Classroom.* Norwood, MA: Christopher-Gordon Publishers, Inc.

1. Product Guidelines

a) Prepare an oral report that you will deliver to the rest of your department; this report should indicate:
   i) What have you learned about networked technology integration that is probably of greatest importance to your colleagues
   ii) What your department should do concerning technology integration
   iii) Why are you making the recommendation

b) Create an Internet Workshop unit that will be posted on the school Internet site. Your unit will be comprised of 3 parts, Internet Activity, Internet Inquiry and Internet Project, which will guide students to bookmarked Internet sites integral to your learning purpose.

2. Guiding Questions

- What are networked technologies and why use them in the classroom?
- How does the use of networked technologies fit into the teaching-learning process?
- What kinds of learning experiences on the Internet are educationally purposeful and what are the criteria or conditions for successful learning experiences?

3. Assessment

- Self - assessment. Each participant will create a personal learning plan that includes a profile of the learner's abilities, needs, goals and achievements in relation to the scope of this project. In addition, the facilitator will provide a set of web authoring competencies for participant self- assessment.

4. Time Constraints

This project will be conducted over a 4- month period and provide you with a minimum of 8 days release time.