A STUDY ON THE INFLUENCE OF A PROBLEM-BASED LEARNING APPROACH TO TECHNOLOGY INTEGRATION ON TEACHER BELIEFS AND ATTITUDES

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The University of Dayton, 2002

James. B. Rowley, Ph.D.

The purpose of this study was to follow up earlier research and explore the impact of a change in the learning environment of a professional development course on the beliefs and attitudes of K-12 teachers. This course, developed by the Institute for Technology-Enhanced Learning (ITEL) at the University of Dayton, was designed to train classroom teachers in adopting a Problem-Based Learning (PBL) approach to technology integration. The subjects for this study were 14 self-selected in-service teachers (intervention group) from area partner schools that received the training in the 2001 - 2002 school year, and 17 in-service teachers from the same schools that received the training in the 2000 - 2001 school year (comparison group).

Instruments used included two Lickert-scale inventories - a self-assessment survey (SAS) and a REAL belief inventory (RBI), a semantic differential survey - REAL environmental inventory (REI), a demographic survey, and an open-ended questionnaire. A pre-test/post-test design was used to assess changes in teacher beliefs and attitudes using the RBI, consistent with Grabinger's Rich Environments for Active Learning contexts. Teachers were also asked to commit to turning in PBL units that demonstrated their use of the ADISC model to integrate technology into classroom practice. In addition post-test RBI scores of the intervention and comparison groups were compared, to determine gains due to environmental changes.

Post-test scores of both groups, on the REI, RBI and SAS, were not significantly different, although absolute values indicate that the workshop had the same (positive) effect on both groups. This may mean that the change in environment through group design (grade-level groupings vs. mixed grade levels in the previous study) or difference in the end product (creation of a CD-ROM vs. a simulation in the previous study) had no significant influence on the teachers' beliefs. From the responses to the open-ended questionnaire it may be concluded that, regardless of variations in the demographics, the technology-enhanced, constructivist-based, problem-based learning environment of ITEL's professional development course positively impacted 12 of 14 teachers from the intervention group. Discrepancies in the results of the different surveys indicate a possible need to re-examine their validity and refine the instruments.

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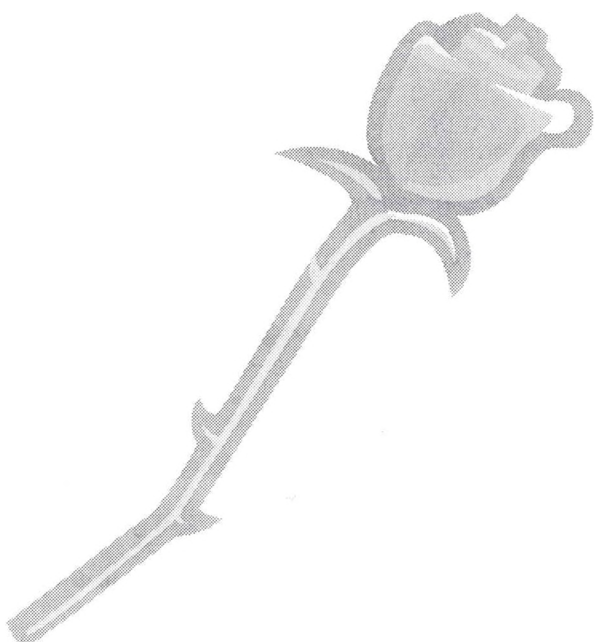
For my Mom, Dad, Jacinta & Mark, I did it!



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CHAPTER I

INTRODUCTION

It has been more than a decade since technology was introduced in schools across the United States. Ever-increasing demands are being placed on schools to ensure that students are well equipped to enter the workforce and navigate a complex world (Roschelle, Pea, Hoadley, Gordin, & Means, 2000). Research indicates that computer technology can help support learning, and that it is especially useful in developing the higher-order skills that encompass critical thinking, analysis, and scientific inquiry. But, the mere presence of computers in the classroom does not ensure their effective use. Educators have been grappling with various models for effectively integrating technology into the curriculum. Recent research studies indicate that classrooms are being connected with little thought or planning of how these connections will be utilized (Bray, 1999). The allocation of hardware, software, and integration training has been slow (Dias, 1999). Barbara Bray, a professional development specialist, points out that teacher training, where it exists, is primarily in the use of operating systems and application software, and measured in hours of seat time (Bray, 1999). As a result, many schools have adopted specious strategies for the integration of technology. This has become a critical point of contention in today's educational landscape as taxpayers' are demanding accountability from schools in terms of student performance on standardized measurements related to the use of technology. As the budget allotted for technology in schools has risen from the millions to the billions in annual spending, policy makers and members of the media are beginning to ask for evidence of improvements in student learning (Lemke, Coughlin, Boysen, Solmon, Fagnano, Schiff, & Schacter, 1998).

These requests for evidence of improvements haven't gone unheeded. In the fall of 1999 the U.S Department of Education, in consultation with key stakeholders, undertook a strategic review and revision of the national education technology plan. In December 2000, it revised and released a new education technology plan and summarized the progress made in student learning gains since 1996 (U.S. Dept. of Ed., 2000). It also urged national, state, and local action to support ongoing efforts to improve teaching and learning with technology. The outcomes related to student gains due to technology, as stated in the report, were that "the nation has made tremendous progress toward achieving the 1996 national educational technology goals." It also confirmed, "the investment in computers and Internet access, professional development, technical support and content has allowed many elementary and secondary school teachers and students to reap the benefits of powerful teaching and learning applications." The report charted the rapid pace of technology from 1996 to 1999. A meta-analysis of studies in "Findings on Computer-Based Instruction" (Kulik, 1994) demonstrated that with technology student achievement increases, students learn more in less time and undertake more ambitious school projects, and they have more positive attitudes toward classes that use technology. The George Lucas Education Foundation (GLEF), a nonprofit organization established in 1991 by filmmaker and educational visionary George Lucas, gives hundreds of innovative examples of teaching and learning with technology that are already successful in our nation's schools (GLEF brochure, 1991). Experiences where students conduct original research, collaborate with peers, connect with professionals in a particular field of study to get answers, share the excitement of discoveries with scientists and explorers as they happen, and participate in career simulations, and those where students with disabilities are empowered by assistive technologies are just drops in the ocean of powerful learning experiences happening everyday because of technology.

Research has shown that the classroom teacher is the key to all successful learning experiences for students relating to technology. Government and academic reports have stated that there is no competition between teachers and computers. It is not either/or when it comes to the choice between computers and teachers. Computers cannot replace teachers nor compensate for good teaching (Trotter, 1999). A Presidential advisory panel on educational technology concluded in 1997, after reviewing a wide array of research, that as schools continue to acquire more and better hardware and software, the benefits to students will increasingly depend on the skill with which some 3 million teachers are able to use these new tools (PCAST, 1997). Software publishers back up this sentiment as well by agreeing that competent teachers are needed to derive academic gains from digital content. Jane L. David, the director of the Bay Area Research Group in Palo Alto, California, wrote in 1995, "Computers did not replace teachers, nor did they decrease interaction among students; in fact, the opposite has occurred. Teachers are the key to whether technology is used appropriately and effectively, and technology increases conversation, sharing, and learning among students and between students and teachers" (cited in Trotter, 1999). Therefore, this research study targets teachers and professional development geared towards effective technology integration.

Background of the Study

Professional development is one of the newly revised goals set forth in The National Education Technology Goals report (ISTE, 2000), to make the most of the digital content in the classroom. Linda Roberts, the Director of Technology at the U.S. Department of Education, strongly believes that an investment in technology requires a simultaneous investment in teachers. Therein lies the key to successful technology integration and student learning. Federal lawmakers are in agreement with this philosophy and showed their support through funding a number of grants over the last few years on a variety of initiatives that ranged from improvement of individual teacher skills to collaborative initiatives between schools, higher educational institutions and community stakeholders. Examples of these grants are the Technology Innovation Challenge Grants program in 1998, which directed $30 million to 20 model projects designed to develop teachers' skills in using technology (Trotter, 1999). Other initiatives included the Challenge Grants which were awarded to school districts in partnership with higher educational institutions, museums, libraries, and private profit and non-profit organizations to serve as educational technology test-beds (U.S. Dept. of Ed., 2000). To help future teachers become proficient in the use of modern learning technologies, the U.S. Department of Education created the Preparing Tomorrow's Teachers to Use Technology (PT3) grant program. Funded in part by an Ohio Learning Network grant awarded to the University of Dayton's Institute for Technology-Enhanced Learning (ITEL) in August 2001, this training program developed from a partnership between ITEL and three area schools. Under this initiative, ITEL worked in conjunction with the partner schools to create this experiential Problem-Based Learning (PBL) model that strategically combines the new electronic tools of today with a problem-based learning approach to enhance the ability of students to actively participate in the learning process by exploring, reasoning, inventing, communicating and persuading. This research-based model simulates the Rich Environments for Active Learning (REALs) recommended by Grabinger and Dunlap (1996).

REALs are comprehensive instructional systems that encourage students to develop initiative and responsibility for their own learning within active and meaningful contexts. The following are the key characteristics of REALs as stated by Grabinger and Dunlap (1996, p. 212):

- Encourage student responsibility, decision making, and intentional learning in an atmosphere of collaboration among students and teachers
- Promote study and investigation within meaningful, authentic, and information-rich contexts
- Utilize participation in activities that promote high-level thinking processes, including problem solving, experimentation, original creations, discussion, and examination of topics from multiple perspectives

The roots of PBL can be traced to the progressive movement, especially to John Dewey's belief that teachers should teach by appealing to students' natural instincts to investigate and create (Delisle, 1997). Delisle indicated that all education involves either problem solving or preparation for problem solving, which forms the basis for PBL. PBL provides a structure for discovery that helps students internalize learning, leading to greater comprehension. It is in our efforts to overcome our greatest challenges that we experience our most significant learning moments. This is the principle underlying PBL, a teaching technique that educates by presenting students with an 'ill-structured' problematic situation that leads to a problem for them to solve. Torp & Sage (1998) explain that such a situation is messy, complex, and dynamic. Not enough information is provided to the learner, so the situation requires inquiry, information gathering, and reflection. Assumptions and opinions are in a constant state of flux as students decide upon a solution. Students learn through their attempts to solve the problem while working collaboratively in groups in simulated real-world settings. This type of learning is active, experiential, and set in authentic contexts similar to REAL (Grabinger, 1996). This model is a shift away from the classroom practices of short, isolated, teacher-centered lessons to a greater emphasis on learning activities that are interdisciplinary, student-centered, long-term, and integrated with real-world issues and practices (U.S. Dept. of Ed., 2000). PBL is a curriculum organizer, grounding learning in the context of required curriculum and content standards, using authentic assessments and evaluation procedures (SCORE Internet Resources, at http://www.score.k12.ca.us/). It is geared toward persuading educators to transform their teaching and learning styles in and out of the classroom. Insights shared by educators having made this transition speak of new energy and enthusiasm for their classes, and students that praise challenging tasks that prepare them for learning. Examples can be found at http://www.udel.edu/pbl/.

Purpose of the Study

The focus of this research study was to continue the development of a new practice-based professional development model for implementing PBL in a technology-enhanced environment. The purpose of this research was to study the impact of a 35-hour professional development experience on the professional attitudes of classroom teachers with regard to problem-based learning in a technology enhanced environment.

Specifically, this study sought to question what happens when the learning environment is changed in a professional development workshop. This study also sought to impart knowledge of PBL and to model the steps of its implementation, to allow teachers to learn so that they may better relate to the range of feelings, from dissonance to elation, that students experience through the process. To explore this question, this research built on a previous study (Oberlander, 2002).

The subjects for this study were 14 self-selected in-service teachers (the intervention group) that received professional development training from ITEL during the 2001-2002 school year and 17 in-service teachers from the same partner schools that received the training in the prior 2000 - 2001 school year (the comparison group).

Quantitative data were collected while using a mixed-method design for the study. Instrumentation included two Lickert-scale inventory-based surveys, a semantic differential survey, a demographic survey, and an open-ended questionnaire. A pre-test/post-test design was used to capture changes in teacher beliefs and attitudes using a REAL Beliefs Inventory (RBI) consistent with Grabinger's Rich Environments for Active Learning contexts. Teachers were also requested to commit to turning in PBL units that demonstrated their use of the ADISC Model to integrate technology into their classroom practice. In addition post-test scores on the RBI were compared for the experimental and control groups, to identify gains due to environmental changes.

Definition of Terms

Technology-Enhanced Learning. The use of technology to impact student learning and achievement by employing technology to help students to: comprehend difficult-to-understand concepts; engage in learning; access information and resources; and better meet their individual learning needs. (U.S. Dept. of Ed., 2000)

Curriculum Integration. The infusion of technology as a tool to enhance the learning in a content area or multidisciplinary setting (ISTE, 2000)

Effective Integration of Technology. Effective integration of technology is achieved when students are able to select technology tools to help themselves obtain information in a timely fashion, analyze and synthesize the information, and present it in a professional manner (ISTE, 2000)

ADISC Model. A conceptual frame for the integration of technology into classroom teaching that was developed by James Rowley, ITEL Director. The model classifies technology-enhanced learning activities into five categories: augmentation and adaptation, data management and display, information acquisition and processing, simulation and modeling, and communication and collaboration (Lasley, Matczynski & Rowley, 2002, as cited in Oberlander, 2002).

Constructivism. A philosophical view characterized by the beliefs that: the learning environment helps form the learner's understandings; cognitive conflict determines what is learned; and knowledge develops through social negotiations and evaluation of the viability of individual understandings (Wilson, 1996).

Ill-structured Problem. A situation that is messy and complex. It does not provide enough information, which leads the learner toward in-depth inquiry, information gathering, critical analysis and reflection (Torp & Sage, 1998).

Problem-Based Learning (PBL). A curricular reform that unites the learning of content and skill in the context of an ill-defined situation by collaboration with other learners, under the guidance of a tutor (as cited in Oberlander, 2002).

MindTools. Computer-based tools and learning environments that have been adapted or developed to function as intellectual partners with the learner, to engage and facilitate critical thinking and higher-order learning (Jonassen, 2000).

Limitations of the Study

There are several limitations affecting the validity of this study. One of them is the threat to validity posed by the fact that the change in teacher attitudes towards PBL and technology integration may not be due to a change in environment but due to the fact that the instructor and coordinators are more proficient. Similar threats to validity experienced in the previous study (Oberlander, 2002) apply to this study as well. Lack of random selection of subjects (teachers volunteered for the treatment) poses another limitation. Teachers that volunteered for the program received credit if they completed course requirements satisfactorily. They were also paid $600 for their PBL units that were turned in. As Oberlander (2002) surmised, "Such incentives, while respecting the professionalism of the teachers, might result in a group of individuals that were initially predisposed to the PBL teaching in a technology-enhanced environment."

Significance of the Study

This study is significant because it represents an attempt to learn more about the special kinds of environments that promote changes in teacher attitudes and beliefs towards Problem-Based Learning and technology integration. It is a sequel to the research study by Oberlander (2002), and will provide invaluable information to the coordinators of this workshop for Year 3.

CHAPTER II

REVIEW OF THE LITERATURE

This review focused on research undertaken to gain a deeper understanding of Problem-based Learning (PBL) and the use of computers as Mindtools in the context of developing effective professional development programs to impact changes in teacher attitudes and beliefs. This was the first step towards effecting long-term change in teaching practice. It provided research-based findings favoring this particular combination of theory and practice in a technology-enhanced learning environment as an effective model for meeting the needs of learners today. This review looked at research findings in three major areas - PBL, the use of computers as Mindtools, and the combination of PBL and computers to develop an effective model for technology integration.

Definition and Characteristics of PBL

PBL is focused, experiential learning (minds-on, hands-on) organized around the investigation and resolution of an ill-structured problem (Torp & Sage, 1998, p.14). An ill-structured problem is a situation that is messy and complex. Such a situation does not provide enough information, which leads the learner towards in-depth inquiry, information gathering, critical analysis, and reflection. This process aids in developing higher-order critical thinking skills. PBL has three distinct characteristics (Torp & Sage, 1998, pp. 14-15):

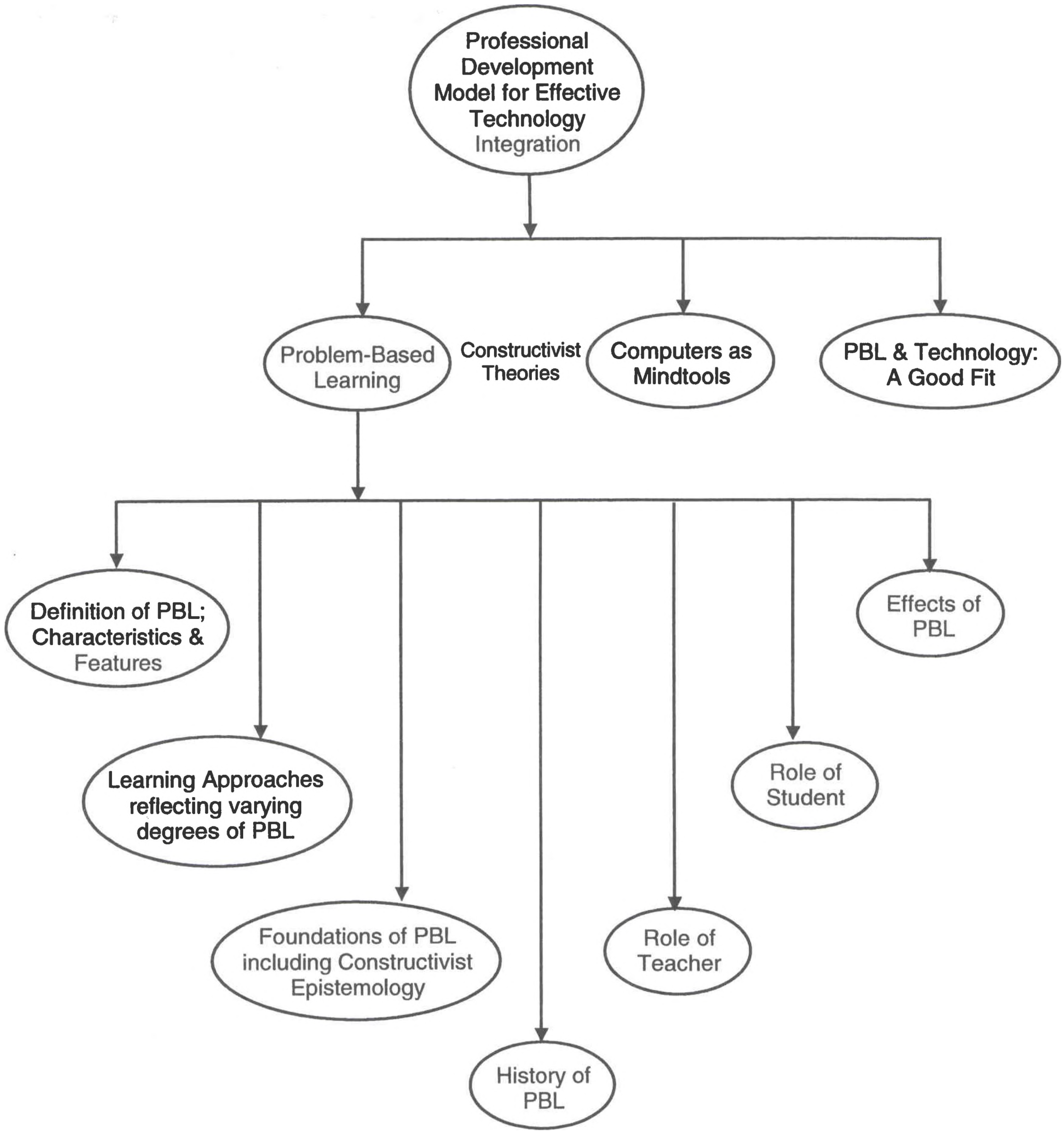


Figure 1. Schematic showing the organization of the literature review

The first characteristic of PBL is that it creates opportunities for learners to become engaged as stakeholders in the problem situation, bringing different perspectives to the equation as they invent and design solutions derived from their personally constructed meanings.

The second characteristic is that PBL is both a curriculum organizer and an instructional design strategy. It organizes curriculum around the holistic problem in relevant and connected ways.

The third characteristic of PBL is the creation of the learning environment in which teachers coach student thinking and guide student inquiry. If properly facilitated, the learners' in-depth explorations lead them to learn necessary concepts and content critical to understanding and solving the problem.

PBL becomes a dynamic process as information is constantly processed and new knowledge structures are built. This may change or open up new avenues for investigation and the development of solutions. Solutions to any given problem may be multiple and varied. Learners have to constantly collaborate and work cooperatively to decide which direction to take. Torp and Sage (1998, pp. 5-14) provide examples of how PBL keeps the learners highly active and motivated throughout the learning experience. A problematic situation is changing and tentative, and has no simple or fixed solution. Even when students decide upon a solution, there are probably multiple ways in which it may be achieved. This problem is used as the stimulus and focus of student activity.

For an instructional model to be recognized as a strong instance of PBL, it has to contain five criteria critical to problem-based learning, that were summarized by Thomas (2000):

- *Centrality* includes the problem or the project that is the central defining force of the curriculum.

- *Driving question* includes the “ill-structured” problem situation that creates cognitive dissonance in the minds of the learner and acts as a stimulus to want to know more.
- *Constructive investigation* is a goal-driven process that involves inquiry, knowledge building and resolution. As Thomas explains, investigations could include inventing, decision-making, problem finding, problem solving, discovery or model-building processes, although the central activities of the project must involve the transformation and construction of knowledge on the part of the students (Bereiter & Scardamalia, 1999).
- *Autonomy* is the student-driven aspect of PBL. The teacher does not predetermine problems and/or projects. PBL projects incorporate a lot more student choice, unsupervised work time, responsibility and self-regulated learning than traditional instructional assessments.
- *Realism* is the real-world connection component that makes the learning relevant and meaningful to the learners. Characteristic of PBL is the authenticity of the topic and the tasks, the roles that students simulate, and the context in which the project/problem is carried out. PBL incorporates real-life challenges where the focus is on authentic (not simulated) problems or questions and where the solutions have the potential to be implemented.

In their research on problem-based learning in relation to the teaching and learning context, Jean Pierce from the Northern Illinois University and Beau Fly Jones from Ohio Schoolnet had some interesting findings on the various learning approaches that have PBL characteristics, albeit to varying degrees. They provided a continuum that rated these learning approaches (see below) and the features of contextual learning to varying degrees.

- *High in PBL, high in context* were co-investigations, co-development, and co-learning projects; expeditions; sustained internships, and action research.
- *High in PBL, low in context* were cases, simulations, progressive problem solving, process drama, anchored instruction, and PBL classroom research problems.
- *Low in PBL, low in context* were isolated hands-on activities and thematic projects.
- *Low in PBL, high in context* were episodic field trips, service learning, shadowing, procedural learning, and activity simulation kits.

In regard to *project*-based learning, also referred to as PBL in the literature, the distinctions need to be clarified. Camille Esch of SRI International provided a summative evaluation of this comparison in an online publication available at http://pblmm.k12.ca.us/PBLGuide/PBL&PBL.htm. She pointed out that both problem-based learning and project-based learning share several characteristics, such as their purpose to engage students in authentic real-world tasks, open-ended projects or problems with divergent solutions; a student-centered approach with the role of teacher as facilitator or coach; the use of cooperative groups; a focus on information seeking and gathering; and an emphasis on authentic, performance-based assessment. She also pointed out the differences. The key difference that she highlighted is that project-based learning typically begins with an end product or "artifact" in mind and a clearly stated problem. On the other hand, in problem-based learning, "the problematic situation is the organizing center for the curriculum." Inquiry and research, rather than the end product, are the primary focus of the learning process.

History of PBL

PBL evolved from innovative health science curricula introduced in North America over 30 years ago. The original PBL model was developed for use with medical students at the McMaster University in Canada (Barrows, 1992). The model was designed to help interns improve their diagnostic skills through working on "ill-structured problems." The process begins when medical students are introduced to a diagnostic problem, usually a patient with a complaint or illness. By using a database of information and test data on this patient and guided by a facilitator that plays the role of a coach or a Socratic questioner, students are led to construct a diagnosis by generating hypotheses, collecting information relevant to their ideas (e.g., interviewing the patient, reading test data), and evaluating their hypotheses (Thomas, 2000). Students fine-tune their hypothetico-deductive thinking skills (higher-level critical thinking skills). This format has been adopted in the use of case-based methods in medical, business, and legal education to help students become proficient at preparing briefs and making presentations (Williams, 1992, as cited in Thomas, 2000).

More recently, the PBL model has been extended to mathematics, science, and social studies classes at the elementary, middle, and secondary school levels (Stepien & Gallagher, 1993). The bulk of experimental studies in PBL at the K-12 settings originate from the Illinois Mathematics and Science Academy (IMSA) in Aurora, Illinois where faculty developed a one-semester problem-based course entitled Science, Society, and the Future that focused on "unresolved science-related social issues" (Thomas, 2000). The work that Torp & Sage (1998) pursued is directly relevant to this study, as is their focus on training teachers to use PBL in K-12 settings in various disciplines or interdisciplinary contexts.

Foundations of PBL

Problem–Based Learning is built upon a constructivist epistemology. What does this mean? Epistemology is the branch of philosophy that is concerned with the nature of knowledge and understanding – its foundations, assumptions, and validity (Reiser & Dempsey, 2002). We all have epistemological beliefs, some formal and others implied. These beliefs influence how we design our instruction, sometimes consciously, sometimes unconsciously (see, for example, Armstrong, Henson, & Savage, 1997; Segall & Wilson, 1998). Kuhn (1999) identified a continuum of formal epistemological perspectives, suggesting basic differences in assertions, views of reality, and the role of critical thinking. Reiser and Dempsey (2002) elucidate that positivists believe knowledge exists independent of the individual learner. It follows that they generally employ instructional methods designed to transmit knowledge so as to help individuals "learn" or duplicate it. Conversely, relativists believe that knowledge is not absolute but rather what the individual constructs. They typically rely on instructional methods that are intended to promote the judgments and evaluations that facilitate personal interpretations and refine understanding (Reiser & Dempsey, 2002). Traditional instructional practices have tended to reflect a positivist perspective, characterized by beliefs that reality exists external to the individual (see, for example, Hwang, 1996; Jonassen, 1991; Yarusso, 1992). Relativist epistemology seems inconsistent with these traditions. Relativists assume that individuals actively assign different meanings to common objects, events, and circumstances that cannot be judged as simply "correct" or "incorrect" by comparing to convention (see, for example, Driscoll, 1994; Hwang, 1996; Wilson, 1996; Yarusso 1992). Reiser and Dempsey (2002) summarize that knowledge, therefore, is uniquely constructed through the negotiation of meaning, in an effort to evolve personal understanding, rather than being uniformly transmitted. Instructional design involves the creation of materials and activities that assist learners in constructing and refining individual representations and personal understandings (p.73). Different epistemologies have different psychological frameworks, which in turn have different implications for instructional design and practices. By design, instructional materials and methods should reflect beliefs and evidence about the nature of learning and understanding in ways that are consistent with key foundations and assumptions (Armstrong, Henson, & Savage, 1997; Segall & Wilson, 1998).

Constructivism is a relativist theory of learning and epistemology that powerfully informs educational practice today. It is also the framework for problem-based learning. In our quest for better ways to teach and learn, constructivism and constructivist-based approaches, specifically PBL, provide a paradigm for teaching and learning that encompass the evolving needs of learners today. As Torp & Sage (2002) have documented, according to Reigeluth, emerging features for a new educational system for this information age include cooperative learning, thinking, problem-solving skills and meaning making, communication skills, and the teacher as coach or facilitator. These are the essential features of problem-based learning. The simple truth about constructivism, as Perkins (1999) puts it, is that learners control their learning. This lies at the heart of the constructivist approach as well as the PBL approach to education. This is made clear in the Table 1 which outlines the similarities between the five tenets of constructivist teacher practices, as identified by Grennon-Brooks & Brooks (1993), and the elements of teacher practices in PBL, as described in Torp & Sage (1998). It is obvious from the research literature that problem-based learning teacher practices are firmly grounded in a constructivist framework that forms the basis for Problem-Based Learning.

Table 1

Similarities between Constructivist and PBL Teacher Practices

Constructivism	Problem-Based Learning
Constructivist teachers seek and value students' points of view	Teachers of PBL, as part of their mentoring role as coach, seek out and value their students' points of view
Constructivist teachers structure lessons to challenge students' suppositions	As part of the design process in developing a PBL course or unit, teachers of PBL decide on a problematic situation as the focus of the learning experience. This situation is designed to challenge students' suppositions as they strive to make sense of the situation and propose solutions.
Constructivist teachers recognize that students must attach relevance to the curriculum.	Teachers of PBL engage students as stakeholders in a problem situation, providing authentic experiences that foster active learning, support knowledge construction, and naturally integrate school learning and real life, as well as integrating disciplines.
Constructivist teachers structure lessons around big ideas, not small bits of information	By always beginning with a problem situation as the focus of instruction, PBL teachers structure PBL units around big Ideas that often lead to interdisciplinary learning.
Constructivist teachers assess student learning in the context of daily classroom investigations, not as separate events	Teachers of PBL embed periodic authentic forms of assessment that bring to the forefront learners' deeper levels of understanding and knowing, as they progress along a continuum.

Role of the Teacher in PBL

The teacher's role is vital to an effective problem-based learning experience. PBL teachers coach students' thinking, communication, group process, and problem-solving strategies. As Torp & Sage state, "The teacher's role shifts from one of control of what and how students learn, to one of mediation of student learning." The part that differs considerably from the traditional role of a teacher is the role of meta-cognitive coach/guide. As a meta-cognitive coach, the role of the teacher in PBL is facilitation and management. Facilitation includes exposing and facilitating student thinking to reach deeper levels of understanding through diagnosing, mentoring, questioning, and modeling. Educational diagnosing involves identifying students' learning needs and their level of engagement by constant observations, advanced questioning techniques, conversations, and embedded assessments or questioning (Torp & Sage, 1998). This helps the teacher to provide whatever support structures are necessary to aid in student learning. Mentoring as a PBL coach involves not only valuing students' points of view and encouraging their thinking, but also challenging them by inquiring at the leading edge of their thinking (Torp & Sage, 1998). Questioning aids in student understanding and holds students to strict benchmarks of good thinking and reasoning, including specificity, defensibility, examination of bias, and consideration of opposing views (Torp & Sage 1998). This helps them to build bridges from their present understanding to new, more complex levels of understanding (Brooks and Brooks, 1993, as cited in Torp & Sage, 1998). The coach (and mentor) also has a responsibility to maintain appropriate levels of challenge during the PBL experience without letting mentees/students get too frustrated and give up (Torp & Sage, 1998, p. 69). As the curriculum designer, teachers are responsible for developing PBL units that include all the key components of PBL. The model that teachers used for the purposes of this study of the Flow of a PBL Unit is found in Problems as Possibilities (Torp and Sage, 1998, Fig. 5.1, p. 47). The steps outlined in the flow are on a continuum, beginning with problem design and moving on to problem implementation. These steps include:

1. Choosing a relevant problem of worth
2. Developing the PBL learning adventure
3. Building the teaching and learning template
4. Coaching critical teaching and learning events
5. Embedding periodic assessments and appropriate instruction

Role of the Student in PBL

Students used to the more traditional model of teaching are apt to encounter a culture shock when exposed to PBL. They may struggle with their new roles as active thinkers and knowledge constructors and the high degree of ambiguity they face with ill-structured problems. Initially, research shows that frustration levels are high, and learning may not fulfill all preset goals (Torp & Sage, 1998). Over time, however, students engaged in PBL appear to become intrinsically motivated to use self-directed methods aimed at acquiring in-depth understanding. In their meta-analyses of PBL programs in higher-level education, Albanese & Mitchell (1993) concluded that PBL students demonstrated different study practices than other students, and these practices reflected different goal orientations. PBL students were more likely to have mastery goals such as studying to understand and to obtain information needed to solve problems. To achieve their goals, PBL students spent more time using library resources and applying strategies that helped them identify and define problems, than did students in traditional programs (Gallagher, Stepien, and Rosenthal, 1992; as cited in Albanese and Mitchell; Stepien, Gallagher, & Workman, 1993).

Effects of PBL

The scope of research in the field of K-12 education in problem-based learning is not very deep, spanning only the last decade. Research prior to that is available in the areas of medical education, law, health-related fields, business, and the sciences, especially in the areas of higher education and faculty training and development at those levels. John W. Thomas (2000), a member of the erstwhile Autodesk Foundation, did an in-depth review of the research on project-based learning, problem-based learning and other similar learning approaches. In his review on problem-based learning he examined studies done by the faculty of IMSA in collaboration with the Chicago Academy of Science on the effect of PBL on high-school students' academic achievements and problem-solving skills. From the results of this study he concluded that students in the experimental group showed a significant increase between the pre-test and the post-test scores in the area of "problem finding".

Another study that Thomas (2000) reviewed was a PBL study done by Williams, Hemstreet, Liu, and Smith, 1998 (as cited in Thomas, 2000) on the effectiveness of a "packaged" approach to PBL. In this study 117 seventh-grade students were exposed to a PBL program on science concepts presented via CD-ROM. The results showed that they outperformed a control group that received more traditional instruction, although no data was provided.

Thomas (2000) and Torp & Sage (1998) report success for the use of a PBL learning model for other populations and other curriculum domains, but do not include data (examples can be found in Problems as Possibilities by Torp & Sage, 1998). Gallagher, Stepien, Sher, and Workman (1995) reported the successful use of this model by Torp & Sage, 1998 (as cited in Thomas, 2000) with fifth-grade students on problems relating to the ecosystem. Sage (1996) describes the implementation of problem-based learning by science and language arts teams in an elementary and a middle school. Oberlander (2002) describes the implementation of PBL units with fifth-grade, sixth-grade and high school students implemented by classroom teachers soon after an extended PBL professional development workshop at the Institute for Technology-Enhanced Learning (ITEL) at the University of Dayton. Follow-up interviews conducted with selected teachers indicated favorable attitudes towards PBL and increased technology usage in an effective manner for both students and teachers.

PBL and Technology: A Good Fit

"When we see little return on investment, we look for change. When it comes to technology, we need big changes in how we offer professional development and we need them fast." McKenzie (1999).

The last several decades have seen tremendous change in all areas of our lives, how we communicate, conduct business, access information, and use technology. Students and teachers are expected to integrate technology into their daily work. National and state content standards have been developed that may integrate the use of technology, as well as separate technology standards. Content area and technology teachers are expected to ensure that students meet these standards, and they need to find practical ways to assess students' learning progress (Barron, Schwartz, Vye, Moore, Petrosino, Zech & Bransford 1998). In addition, students are expected to not only learn content and technology, but also to think critically and explore actively while doing so. Students today have to function in a very different world than existed even ten years ago. Duch, Groh, and Allen (2001) foresee that future professionals will be expected to solve problems crossing disciplinary boundaries that demand innovative approaches and complex problem-solving skills. They strongly feel that teachers are obligated to rethink how they teach and what students need to learn, to better prepare them for these challenging times.

Research has shown that PBL provides a forum in which these essential skills can and will be developed (Duch, et al., 2001). It has also been documented that PBL naturally integrates technology in a number of ways (Torp & Sage, 1998). Sage (1996) points out that technology is critical to such problem solving, as a *tool* for locating and organizing information, a *means* of delivering a problem, and a *means* for presenting a solution. Through any of these, PBL is a means or an end toward meeting technology standards (which may be found online at www.iste.org).

Tools are useful only if they help in performing a needed or wanted task. Computers are nothing but tools, intellectual tools, and like most tools should support the desired functionality in an efficient, comprehensible manner. When a tool is used to perform a meaningful task the focus is less on the tool itself and more on how it accomplishes the task. Computers are meaningless if they are not used to do something useful. Understanding arises from meaningful activity (Jonassen, 2000). In his book Mindtools, Jonassen (2000) defines mindtools as computer-based tools and learning environments that have been adapted or developed to function as intellectual partners with the learner, in order to engage and facilitate critical thinking and higher-order learning. These tools include (but are not necessarily limited to) databases, semantic networks (Inspiration software), spreadsheets, expert systems, system-modeling tools, microworlds, intentional information search engines, visualization tools, multimedia publishing tools, live conversation environments, and computer conferences. Jonassen argues that students do not learn from technology, but that technologies can support meaning-making by students. This happens when students learn *with* technology. Jonassen developed a framework that is useful in determining when students learn *with* technology. Students learn with technology when they use computers to support the following (adapted from Jonassen, Peck, & Wilson, 1999, as cited in Jonassen, 2000, p.9):

1. Knowledge construction
   - For representing learners' ideas, understandings, and beliefs
   - For producing organized, multimedia knowledge bases by learners
2. Explorations
   - For accessing needed information
   - For comparing perspectives, beliefs, and world views
3. Learning by doing
   - For simulating meaningful real-world problems, situations, and contexts
   - For representing beliefs, perspectives, arguments, and stories of others
   - For providing a safe, controllable problem space for student thinking
4. Learning by conversing
   - For collaborating with others
   - For discussing, arguing, and building consensus among members of a learning community
   - For supporting discourse among knowledge-building communities
5. Learning by reflecting, using computers as intellectual partners
   - For helping learners to articulate and represent what they know
   - For reflecting on what they have learned and how they came to know it
   - For supporting learners' internal negotiations and meaning making
   - For constructing personal representations of meaning
   - For supporting mindful thinking

Technology is the vehicle that powers problem-based learning. Together they form the basis for a new learning & teaching instructional paradigm that targets the serious need for sound technology integration in schools today.

CHAPTER III

METHODOLOGY

This chapter discusses the research design, subjects, setting, instrumentation, intervention, validity and reliability of the instruments, threats to internal and external validity, as well as the data collection and analysis procedures for the study.

Design

The design of this study was a quasi-experimental non-equivalent groups design (NEGD), pre-test/post-test single group and post-test/post-test comparison group that employed both quantitative and qualitative methods. For the purpose of this study the intervention group is referred to as the I-group, and the comparison group is referred to as the C-group. The following is the representation of this research design (Trochim, 2002):

N	O_1	X_1	$O_{1,2}$
N		X_2	O_2

The N in this notation indicates that the groups are non-randomized. X indicates that both the I-group (upper line) and the C-group (lower line) received the treatment. The O's indicate the pretest and the posttests; O_1 indicates that the I-group received the pre-test, $O_{1,2}$ indicates that the post-test of the I-group was compared to the pre-test of the I-group and also the post- test of the C-group, and O_2 indicates that the C-group was also administered a variation of the same treatment and had a post-test-only design (Trochim, 2002).

The populations of each group were composed of subjects that were self-selected into the study, and therefore not randomly assigned to the treatment groups. This is a defining feature of quasi-experimental design. The treatment administered to both groups was the training workshop developed by ITEL, staggered over a period of seven months during the school year. The first group, I-Group, was trained over the course of the 2001 - 2002 school year. The C-Group was the group that had participated in the previous ITEL training program, in the 2000 - 2001 school year (Oberlander, 2002). Both groups came from the same school populations, which was the equalizing factor. Additional demographic data are presented in subsequent sections of this chapter.

Subjects

The subjects for this study were teachers that selected this workshop as part of their training, and represented the full diversity of K-12 academic disciplines and subject areas. The workshop therefore had to address and encompass that diversity by meeting the individual needs of teachers whose experience and education levels were very different. In addition it had to accommodate the different value systems and perspectives that participants brought to this combined learning experience. Two groups of K-12 in-service teachers were studied. The I-group consisted of 14 teachers that volunteered to participate in the PBL staff development program sponsored by ITEL in the 2001 - 2002 school year. The C-group consisted of 18 volunteer teachers, from the same schools, that received similar ITEL-sponsored PBL staff development training the previous year. All participants came from one of the three ITEL partner schools. The grade levels taught by these teachers ranged from 1st through 5th at the elementary level, and 9th through 12th at the high school level. Table 2 provides an overview of the demographics of the three partner schools (Oberlander, 2002).

Table 2

Demographics of the ITEL Partner Schools

Partner School	Demographics
Small-Town	330 students enrolled in Kindergarten through Sixth grade: 10% minority, 12.8 % special needs
Suburban	437 students enrolled in kindergarten through Sixth grade: 12% minority, 26% special needs
Suburban	2,385 students enrolled in grades nine through Twelve: 6% minority, 10.9% special needs

The I-Group volunteered to take ITEL's 35-hour PBL professional-development training course during the 2001 - 2002 school year, while the C-Group teachers received the same professional development training in the 2000 - 2001 school year (Oberlander, 2002). These teachers had the option of receiving graduate credit for the workshop, which was considered a valid university course offering. If the I-Group chose to complete a PBL Unit that integrated technology within the unit and allowed ITEL to publish the unit to a web server as a PBL resource, they were paid $600 upon receipt. This unit was not included in the course requirements; it was optional, and the teachers were given six months after the end of the training to complete the unit.

Setting

The training program was spread over a period of seven consecutive months from October - April during the 2001 - 2002 school year. This included seven monthly sessions with an optional session being a Southwest Ohio Instructional Technology Association (SOITA) Conference related to teaching and technology. The university-based trainer hosted the first all-day session at the university's Learning and Teaching Center (LTC), a state-of-the-art facility especially designed for the use of multimedia and tele-collaboration in university classes. The second training session was held after school hours for a period of two and one-half hours, at the technology laboratory at one of the participating schools. The third (and optional) session was held at a local convention center, the site of an annual regional educational technology conference. The fourth through seventh sessions, each two and one-half hours in duration, were conducted at alternating school sites of the participating teachers after regularly scheduled school hours. Session four was held at a northeastern suburban school district. Session five returned to a meeting room at the university, which later moved to the computer laboratory at the same location. Session six was held at the participating high school and session seven - an all-day session that concluded the training – was held at the Learning Teaching Center at the university where it all began.

Instrumentation

Since this is a follow-up study in ITEL's second year of implementation, the instruments developed for the previous study (Oberlander, 2002) were used for this study as well. All the instruments used from the previous study were reviewed and approved by an Institutional Review Board Chairperson of the university without full committee consideration. The validity and reliability measures, therefore, were inherited with this study. The following five instruments were used, the first four of which were from the previous study:

1. Demographic Survey
2. REAL Environmental Inventory (REI) Survey
3. REAL Beliefs Inventory (RBI) Survey
4. Self-Assessment Survey
5. Open-Ended Questionnaire

Details of these instruments are shown in Appendix A. Instrument 1 consisted of seven multiple-choice questions. The first six questions were answered by the I-Group in the pre-test, while Question 7 - concerning goals relative to teaching and technology – was administered in the post-test. The primary purpose in conducting this survey was to establish equivalence of the I-group and the C-group teachers with regard to the following variables: years of teaching experience, age, previous technology training, and grade level taught. The secondary purpose was to benchmark the I-group teachers' self-perceptions of their knowledge of PBL and goals and objectives relative to technology use after the ITEL training. Both the intervention and the comparison groups completed this survey.

The REI survey (Instrument 2) was developed to serve as a post-evaluation assessment instrument, to evaluate both groups' perceptions of the training (Oberlander, 2002). Since the ITEL training program was specifically designed to immerse teachers in a technology-enhanced, active learning, problem-based environment, it was anchored to Grabinger's constructs for Rich Environments for Active Learning (1996). Research shows the theoretical grounding provided for this instrument supports its content validity (Oberlander, 2002). The REI consisted of 12 paired items representing a semantic differential grounded in Grabinger's REAL constructs (1996). Each of the 12 constructs represented two items along a seven-point continuum from a directive teaching experience to a constructive teaching experience. The highest total score that could be obtained on this instrument was 84.

Instrument 3 was the REAL Beliefs Inventory (RBI), developed specifically to determine how the teachers' beliefs were impacted. Specifically, each teacher's self-reported epistemological orientation was investigated upon completion of the 35-hour ITEL training course. The RBI consisted of 24 statements and was also based on the same six constructs of Grabinger (1996) reflecting a constructivist influence (see

Appendix A). For each construct there were two constructivist teaching-oriented items and two directive teaching-oriented items, amounting to a total of 24 items for the six constructs. Possible responses to these statements appeared in a Lickert scale format, with *strongly agree*, *agree*, *undecided*, *disagree*, and *strongly disagree*, as the choices offered to the respondent, with each choice receiving a numerical rating from 1-5. Therefore, possible scores ranged from 24 to 120, with a score closest to 24 representing an extreme constructivist response. Both groups were administered this survey at the end of the treatment, but the intervention group was administered this survey prior to the treatment as well. Grabinger's Rich Environments for Active Learning (1996) anchors the construct validity of the instrument.

The test for reliability of the RBI was predetermined in the previous study by Oberlander, when an internal consistency test using the Cronbach Alpha was run and generated highly positive results. The t-test of independent samples was employed to determine if there was a significant difference between the RBI scores of the I-Group and the C-group on a sub-analysis of the RBI scores. A test for paired samples was also run to determine if there was a significant difference in the RBI pre-test to post-test scores of the intervention group. A multivariate analysis of variance (MANOVA) was used (generating a multivariate F value, Wilks' lambda) to determine if there were any significant differences between the groups at the construct level of the instrument.

Instrument 4 consisted of the Self-Assessment Survey (SAS). This is a Lickert Scale inventory that collects self-reported data from the I-Group participants with regard to their knowledge of PBL and technology integration (see Appendix A). The I-Group teachers were asked to respond to a total of six questions to indicate if their knowledge level of PBL, skills in designing a PBL unit, and skills in facilitating a PBL unit had increased as a result of their participation in the ITEL workshop. Additionally, the teachers were asked to determine if they had acquired new skills in technology, clarified their personal theories on the purpose of classroom technology use, and acquired new ideas for integrating technology into instructional design as a result of participation in the ITEL workshop. The SAS was administered to both the groups after they received the training. The highest possible score on this survey was 30 points. The higher the score to 30 points, the more favorable the responses.

The Open-Ended Questionnaire (Instrument 5) consisted of six questions designed to elicit teachers' feelings about the workshop, their goals for PBL implementation, and recommendations for improvement of the ITEL course.

Treatment

The treatment consisted of a 35-hour professional development program offered to teachers from the designated ITEL partner schools. Research shows that learning is facilitated in staff development programs if they are delivered in more than one incident, over an extended period of time (Wade, 1984). New to the program was the addition of five Catholic schools as part of a new initiative, providing ten new K-8 teachers to the sampling mix. For the purpose of this study the data from the Catholic school participants were not included for lack of a comparison group. The focus of the treatment was to immerse teachers in a multimedia technology-enhanced PBL experience to simulate the experience of K-12 students engaged in a PBL learning experience.

The theme of the ill –structured problem that was the focus of this PBL experience was "Grizzly Bear – Living Symbol of the American Wilderness." Details of this unit can be found in Appendix B. The focus of this unit was on how teachers could create and design a developmentally appropriate, multimedia, and problem-based learning unit for their students using the Grizzly Bear theme. This theme was selected because it was a topic that the participating teachers knew little about. The goals of the workshop were to provide participants with:

- An understanding of the process and practice of PBL
- An understanding of the constructivist philosophy and the main educational principles involved in PBL
- An opportunity to begin to develop their own problem-based learning materials for implementation in their classrooms
- An opportunity to be immersed in a problem-based learning session with a peer group

Key processes and activities in achieving the workshop goals included *problem-based sessions* in which teachers participated as 'students'. These sessions provided an in-depth experience of the PBL processes including:

- Use of the ADISC model as a framework for technology integration into the PBL unit
- Examples of content to be learned and assessed (from PBL units of the previous workshop)
- Modeling of the tutor/coach/teacher's role in a PBL learning experience
- Understanding of the student's role in PBL through immersion in a group problem-solving process

These sessions encouraged understanding at the 'feeling' and perceptual levels as well as the cognitive and meta-cognitive levels, so teachers could realistically compare and their ITEL experience with their classroom practice. Factors that facilitated this deeper understanding at the cognitive and meta-cognitive levels included:

- *Meta-level discussion and reflection* was used as a key means of generating transfer of skills. It helped to pull together isolated knowledge, skills and experience into a holistic in-depth understanding. Thinking processes were made *overt* - visible, open to challenge, reflective and applied to practice. This helped to ground participants' reflection and analysis within the fullness and complexity of their own teaching situations (Boud & Feletti, 1997). This also helped teachers to identify the relationship between their current theories in use and their theories in belief (Argyris & Schon, 1974).

- Mind-mapping tools such as the Inspiration 6.0 software package was used to show the relational nature of knowledge. It aided in bringing to life the contributions of all the participants' originality and creative thinking. This is important, because problem solving requires both convergent and divergent thinking, and mind mapping is an extremely useful 'mindtool' for exploratory and generative thinking (brainstorming).
- *Technology-enhanced learning environments* were used to create a positive climate for learning. This was especially important since teachers/participants were being encouraged to change, to take risks, and to become more autonomous. Providing access to the necessary "mindtools" (including hardware, software and the Internet) in a learner-supported environment helped participants to develop learning communities (Heron, 1993) within which they could gain both peer support and feedback.
- *Food*, a basic need, was well provided at every session. This was always the first activity on the agenda and one that was much appreciated by the teachers. By the time the sessions convened, teachers were well fed, refreshed, and ready to go.

Since on-going support is a key factor to implementing and sustaining change (Owen, Loucks-Horsley, & Horsley, 1991), the technology coordinators from each of the three ITEL partner schools were present at all sessions and played an active role in the planning and implementation of the entire PBL training course. Through their participation the coordinators became familiar with the PBL process, technology applications, and the software introduced to the teachers. As a result, they were better prepared to support their respective teachers during the following school year and beyond. Staff development is most influential when it ensures collaboration adequate to produce shared understanding, shared investment, thoughtful development, the fair, rigorous test of selected ideas, and the collective participation in training and implementation (Little, 1986).

Observations

Observations were made at each of the training sessions (with the exception of the optional training session at the SOITA Conference) to document the intervention and collect data. These observations are summarized below.

Session 1

This was an all-day session held at the LTC of the university on October 17, 2001. In attendance were the ITEL trainer, I-group, technology coordinators for each of the three ITEL partner schools, and the researcher from the previous study. Both elementary schools had groups of five teachers each, while the suburban high school contributed a group of four teachers to the training program. After the welcome and introductions, the trainer explained the nature and importance of the tasks each of the researchers were responsible for performing.

The activities for each session were designed with active social learning and construction of knowledge in mind, the goal being to immerse teachers in a PBL process similar to what their students would experience.

The session began with an ice-breaking activity (The Griz Quiz) designed to allow participants to meet and get to know one another. The activity was also intended to introduce the topic of Grizzly Bears. It was presented through an advanced multimedia PowerPoint presentation (containing animation, sound clips and video) that was intended to whet the technology appetites of the teachers. Sound effects and animation were appreciated and applauded. The trainer took time to explain PBL and reiterate the importance of the collaborative process in PBL. He explained the basis for grouping according to specific grade levels and how this differed from the previous study that employed groups with teachers from various grade levels. The group categories were grade levels K-2, 3-4, 5-6, 7-8, and 9-12. This was one of the variables that differed from the previous workshop design.

The teachers were introduced to the KWL (Know already, Want to know, Learned) strategy, the Copernic search engine (available via a free download from http://www.copernic.com/index.html), and the ADISC Model. Through the collaborative effort of completing an Internet Treasure Hunt, each group answered predefined questions that the trainer and coordinators developed to help the groups learn about the topic of Grizzly Bears. After the groups reconvened and presented their findings all groups were debriefed, to help learners fill in information gaps that may have been encountered by groups while answering the questions. The trainer fielded a flood of questions from the teachers regarding the creation of PBL units and ended the session with food for thought in the form of the following questions:

- Who are Frank and John Craighead?
- What is the problem of the digital divide?
- What should drive learning - the curriculum or technology?
- How can teachers design and develop a developmentally appropriate PBL unit for students using the Grizzly Bear theme?

Supplemental resources were also provided to the groups on assessment and PBL instructional design (Wiggins & McTighe, 1998, as cited in Oberlander, 2002). The session ended with a Lickert scale evaluation that teachers completed before leaving.

Session 2

This was an after-school session held at a suburban elementary school for two and one-half hours on November 26, 2001. The session began with teachers sharing their experiences of the impact of the first session in their classrooms. For the first part of this session, teachers learned to use Inspiration - mind-mapping software, as they brainstormed different ways to represent their group's thinking on the issues of Grizzly Bears. The coordinators demonstrated the use of the software for brainstorming ideas on the topic of the Grizzly Bear and the connections to the state professional curriculum standards. Following that, a classroom teacher that was a participant in the training workshop the previous year was hired to train the teachers in the use of the software. At the conclusion of the session, the teachers were also given their own copy of Inspiration 6.0 to use in their classrooms. The session ended with a debriefing of the entire class and the Lickert scale evaluation to provide feedback to the coordinators and the trainer.

Session 3

This optional session was held on December 4, 2001at the site of the annual SOITA conference in Dayton, Ohio. The SOITA Conference is a meeting of over 800 K-12 educators featuring demonstrations of technology use, lectures, and displays by hardware and software vendors. ITEL reimbursed the schools for substitute teachers to support the attendance of participating teachers at this all-day conference. The teachers met after the conference for a debriefing/training session.

Session 4

This session was held at a suburban elementary school on January 9, 2002. The agenda for this session included discussion on a performance-based assessment for this group of teachers that would demonstrate their understanding of the use of PBL and technology integration. The creation of a resource, such as a CD-ROM on the Grizzly Bear that could be marketed and distributed was explored as an appropriate assessment for this PBL experience. Next, in their grade-level groupings, teachers explored a CD-ROM on the Bald Eagle that was created by another educational group. They were required to evaluate it and reflect on how they could incorporate the features that they liked into the creation of their own CD-ROM on the Grizzly Bear. A technology coordinator summarized the responses in a PowerPoint presentation that was presented to the class. The following were the highlights:

Slide 1: How the Griz CD might be different

- Audience should be teachers first
- Includes PBL design support
- Has K-12 applications
- Improved navigation (compared to the Bald Eagle CD)
- Richer resources, e.g. data sheets
- More resource links

Slide 2: Possible Griz CD contents

- ITEL Staff Contributions: Comprehensive PBL Units, PBL design template, PBL FAQ's, video clip testimonials from teacher participants
- ITEL Teachers Contributions: PBL lesson plans, multimedia resource recommendations, authentic performance-based assessments, anchors to curriculum standards

- Additional suggestions: feature for students to be able to work on CD-ROM activities and save their work, allowing them to continue later where they left off

By this time teachers were excited, confused, overwhelmed and unsure about the expectations for this project, and asked numerous questions to clarify their interpretations of expectations. They were reassured that the ITEL staff would provide a structure for the CD. In the discussion that followed the meaning of problem-based learning was reiterated in simple terms: "It is getting kids to work together to solve an ill-structured, messy problem that's realistic and important to them, and that requires them to demonstrate in some fashion what they have learned using technology." The teachers were reassured that the ITEL staff would have a complete planning sheet at the next session and would present workshops on using the Internet as a mindtool. Teachers completed their Lickert scale evaluations before leaving.

Session 5

This session was held at the university on February 19, 2002 in a small conference room with access to multimedia presentation tools. It began with a recapitulation of accomplishments at the previous session. Short versions of the PBL lesson plans on Grizzly bears were turned in, and experiences of in-class implementation were shared. One fifth-grade teacher from the class had already implemented a unit on Grizzly bears in her classroom, complete with effective technology integration. The focus of this session was the flow of steps involved in creating a PBL unit. Snippets of the scaffolding process that was pursued through questioning at the leading edge are illustrated below.

1. Meeting the problem (inquiring/investigating)

   "How can teachers use PBL and technology-enhanced learning strategies to educate students about Grizzly Bears, while helping them acquire the knowledge and skill required in specific subjects or at specific grade levels?"

2. Solution Building

   "Since our last session, you have been working in teams to carry out inquiry and investigation relative to our central investigation. Working collaboratively, our group will develop exemplary lessons to be included on a CD-ROM resource for classroom teachers."

3. Question – Design

   a. Grouping
   b. Participants' choice of problem
   c. Assignment of roles

It was explained that it is not uncommon for the teacher to guide the direction of the problem-solving process so as to contain it and focus in on the solution-building process if the need arose, as in the current problem. It was explained that in the problem-solving process, this is a constant struggle for the teacher. From the students' perspective the adjectives that summarized the participating teachers' feelings thus far in the PBL process were "confused", "aggravated", "unclear", and "uncertain". After the work they had done, 4 of the 24 participants acknowledged feeling more comfortable with the process. Additional discussion ensued on lesson plans and PBL units that they were required to create for their project, and the groups were assigned time for the same. For the next part of the session, the use of the Internet as a mindtool to create web quests, scavenger hunts, etc., the group was moved to a computer lab located in the same building at the university. The web quest activity for the groups –"Action Jackson" (at http://www.kn.pacbell.com/wired/fil/pages/webgrizzlyjil.html) – was introduced. This was used as a springboard to allow the teachers to experience the higher-order thinking that is evident in the participation of such an activity, following which the web resource that was used to create it – Filamentality 2.0 (at http://www.kn.pacbell.com/wired/fil/) – was briefly demonstrated. The session ended with a debriefing and completion of the Lickert scale evaluations.

Session 6

This session was held on March 14, 2002 at the suburban partner high school. The agenda for the final session was discussed, expectations for the presentations were communicated, and questions from the teachers were answered. The "product" to be turned in at the final session – that included all documents created in Microsoft Office programs and burned onto a CD-ROM – was explained, and the groups were given time to collaborate. After group discussions the teachers split up to attend mini-workshops conducted in different locations at the high school, to hone their technology skills in various areas. The workshops offered included inserting clipart, sound and video; using digital cameras and scanners; PowerPoint at the beginner and advanced levels, Kid Pix; and Microsoft Word for webpage development. Assistance was offered to any group that needed it. After the mini-workshop sessions the groups reconvened in the meeting room and were debriefed. Teachers filled out their Lickert scale evaluation before leaving.

Session 7

This session, the grand finale, was scheduled for April 16, 2002 in the Learning Teaching Center of the university. The excitement was evident from animated interactions between the members of each group as they reviewed material and set up artifacts for their presentations. After reviewing the agenda, the trainer made this opening statement, "I'm hoping that in the process of getting ready for today you felt some degree of pressure, uncertainty, ambiguity, and frustration. Feeling the pressure to deliver. I suggest to you that that is a powerful part of the process. It develops a sense of responsibility and ownership." The mission of the class, which was to produce a commercially viable CD-ROM, was then restated. The presentations by the various groups are summarized below.

K-2 grade team. This team was comprised of five members. They began with a video clip of the Grizzly Bear embedded in a PowerPoint presentation, and moved into a scavenger hunt set up for the teachers in the lounge area of the LTC, with music playing in the background. The team had the teachers create dioramas with the objects found in the scavenger hunt. The posed question for student investigation was, "What happens when bears and people meet?" To wrap up their presentation a member of the team taught the group a rap song enhanced by a clapping rhythm. The presentation was very well received, even by the teachers from the upper grade levels.

3-4 grade team. This team experienced technical difficulties throughout their presentation. The sound effects and links to URL's that were incorporated in the PowerPoint presentation would not work. The presenter began to feel frustrated with the situation but was urged, along with the rest of the team, to verbally share the interdisciplinary PBL activities that each of them had contributed to the project. For math, a teacher used websites to get information to create a table and pictograph that depicted the declining population of the Grizzly bear. For Language Arts, the activity involved writing a persuasive letter to a government official on where to put the Grizzly bear. Students were then required to create a persuasive brochure and a link to the letter, "Where Oh Where to put the Grizzly Bear?" The Social Studies activity was designed to let students create a diorama of the ideal habitat of the Grizzly, to increase the population of Grizzlies. They were able to play the "Jeobeardy" game with the participating group even though it was not fully functional due to the technology glitches.

The class enjoyed this activity. At the conclusion of the presentation it was emphasized that technology failure was not a showstopper, since content was still there.

5-6 grade team. This team began with a PowerPoint presentation that included many links to cool websites about the Grizzly bear. One website contained a neat slide show that was used in a 5th grade class. A huge grizzly bear artifact was displayed, the culmination of a 5th grade class project. Groups in this class created the grizzly in steps- trace, cut, color, staple, stuff. While a group worked on one of these steps, the remaining groups read and collected information from the Internet to answer the question, "If you could ask a Grizzly bear expert any question what would it be?" The student groups color-coded the questions and answers on little index cards that were attached to the huge Grizzly Bear they created. Students then shared what they had learned, using the bear for demonstration. They also shared the bear with other classes at the school. Eventually, a drawing was held and the winner got to take the bear home.

Two other team members initiated a brainstorming session about Grizzlies, involving the participating group. They came up with a list of categories such as characteristics, habitat, behaviors, protection and conservation of Grizzlies. Each of the participating groups was given a category and, using a Hotlist, searched the web for answers to the questions. If interesting vocabulary was encountered in relation to the topic then, following teacher approval of the word, the student used the puzzlemaker web resource site (at http://puzzlemaker.school.discovery.com/) to generate vocabulary activities to share with peers. The Social Studies component included the "Recovery Efforts of Grizzly Bears," in which students were required to create a website with summarized links.

7-8 grade team. This team also experienced technical difficulties with sound effects. One of the team members, a 7th grade teacher, implemented her lesson with her class and shared how much her students helped with the preparation of the presentation.

Another teacher from the team shared her contributions. After attending the PowerPoint mini-workshop, she used this application for the first time to investigate "The Big Questions," and inserted hyperlinks to various Internet resources to support the in-class investigation. Another teacher from the group explained that he had set his unit up as substitute lesson plans. His focus was on "group rules." He gave the example of Lewis and Clark. "When a group of people encounters the animals what does the group do?" He incorporated religious themes (saints) throughout his lesson, focusing on "how we all rely on each other," through the use of simulation. He ended with the observation that students at the 7-8 grade level learn more from each other than they do from the teacher.

9-12 grade team. The technology coordinator navigated the team's presentation while the contributing teachers expounded on their lessons. This group created a web page on their school intranet. The first team member started with an Inspiration web using the main idea – "How does human activity affect the habitat and survival of the Grizzly bear?" The second team member demonstrated his Treasure Hunt web activity created in Filamentality and tied to the Effects of Maslow's Hierarchy of Needs theory. The third team member said he would use the Hotlist site that he created as an opening for a chemistry lesson, focusing on water quality issues. He also created a web-based Treasure Hunt activity. The fourth team member stated, "It was important for me to develop a philosophical base." He commented, "I was very happy to see that the elementary people were doing the same thing." He focused on the difference between the "Dominant World View" and the "Deep Ecologist View" and created a multimedia search on Ecology. The question to be investigated was, "What is the effect of human population growth and the resulting human movement into bear territory on Grizzly bears?" He divided his lesson plan into four phases.

After the presentations the class broke up for lunch. Following lunch, the importance of this study and the data generated and collected were impressed upon the participants. They were then given evaluation surveys, which they completed in approximately 35 to 45 minutes. This was followed by a debriefing session, some of the comments from which are reproduced below.

"Evening at Chaminade (computer labs) with Filamentality could have been longer, was very beneficial."

"Could have used guidance in the very first class, in evaluating what technology skills I had and what technology skills I should be working on."

"You decided on what the final product should be."

Questions and comments from the teachers were addressed and they were reminded of the template to be used to create PBL units that would be implemented in their own classrooms the following school year. They were also reminded of the ADISC model for technology integration that ITEL developed, and its use was re-explained using examples from the presentations. The session concluded with the distribution of forms for university credit and reimbursement.

Validity of the Instruments

Research shows that validity is the evidence that a test or survey measures what it is intended to measure (Krathwohl, 1993). The validity and reliability for each of the instruments except for the open-ended questionnaire have been inherited from the previous study of ITEL participants for the 2000 - 2001 school year. In addition to the RBI and REI being grounded solidly in theory, Oberlander (2002) performed a crosscheck with the trainer and the technology coordinators of the partner schools (who participated in *both* studies) to ensure that the surveys were evaluated for content validity.

Reliability of the Instruments

Reliability is defined as "the evidence that a test measures consistently in some respect" (Krathwol, 1993, p.741, as cited in Oberlander, 2002). Using the analysis procedures of the SAS statistical software program, a Cronbach's Alpha test for internal consistency was run, resulting in a 0.70 coefficient alpha score. This was judged to provide satisfactory evidence of reliability for the RBI (Oberlander, 2002).

Data Collection Procedures

Data collection for the I-group began on October 17, 2001 when the participants read and signed a consent form giving Oberlander (2002), the researcher from the previous ITEL study, permission to administer and use the surveys as a comparison group for the analysis of her study. To fulfill these requirements each participant was assigned a numeric code that only the researchers could link to a specific participant. The researcher then reutilized this data as the pre-test data for the purpose of this study. At the end of every consecutive session thereafter, a form of ongoing assessment was used. Teachers were required to complete a Lickert Scale-type informal evaluation that provided immediate feedback to the coordinators and the ITEL trainer regarding the organization and content of that session. The final evaluation data was collected at the end of the 35-hour workshop on April 16, 2002.

Data Analysis Procedures

A detailed description of the data analysis procedures used for the Demographic, REI, RBI, and SAS survey instruments for the I-group and the C-group is shown in Appendix C.

Threats to Internal Validity

The selection history threat is a valid concern for this design as the teacher participants for both the I-group and the C-group came from the same schools, but were administered the tests six months apart. It is possible that through interactions with the comparison group prior to the beginning of the study, the participants in the intervention group could have become more pre-disposed to PBL and technology integration even before the study began. In this case the change in beliefs and attitudes towards PBL would not be related solely to the impact of the treatment. Since random selection of the participants was not possible, the only other way to account for this threat was to make sure that both groups are at least probabilistically equivalent (Trochim, 2002). This was done through the demographics survey to prove similarities exist between both groups.

Threats to External Validity

As Oberlander (2002) surmised, in a quasi-experimental study with two groups both population and ecological validity have to be taken into consideration for effective design implementation of the study. Oberlander's recommendations were taken to address and account for these threats, since this study was a replication of the previous study. The following areas were identified and accounted for:

Population validity – the presence of the comparison group teachers in the buildings throughout the school year could have sensitized the epistemologies of the intervention group of teachers to a more constructivist stance.

Ecological validity – (a) Failure to describe the independent variable explicitly. To control for this threat, a detailed description of the intervention was provided, to ensure replicability. (b) Novelty and disruptive effects - Although the novelty of this treatment might create more enthusiasm for this approach, balancing this effect was the amount of extra work the teachers had to spend in planning, collaborating, designing and implementing the assignments involved. (c) Experimenter effect – This was limited to non-existent, since the researcher did not actively participate in, but merely observed at, the training sessions.

CHAPTER IV

RESULTS

Analysis of the Demographic Survey

Both the I-group and the C-group received the treatment. The I-group was comprised of 4 males and 10 females, while the C-group was comprised of 4 males and 13 females. The distributions of these subjects between the different categories of schools and grade levels are shown in Tables 3 and 4, respectively.

Table 3

Distribution of Teachers from Each of Three School Categories

Group	School Category		
	Suburban Elementary	Small-town Elementary	Suburban High School
I-Group	5	5	4
C-Group	6	6	5

Table 4

Distribution of Teachers by Grade Level in Each Group

Group	Grade Level		
	K-3	4-8	9-12
I-Group	6	4	4
C-Group	5	9	4

Demographic data were collected on the following variables:

- Age
- K-12 teaching experience
- Technology training hours
- Personal goals relative to teaching and technology
- Knowledge of PBL prior to participation in the ITEL workshop

Information from the demographic surveys indicates that the cumulative experience of the C-Group was significantly greater than that of the I-Group (Table 5). In fact, half the I-Group had less than five years teaching experience. From Table 6 it can be seen that the average age of the I-Group teachers is also significantly lower than that of teachers in the C-Group. While 35 percent of the teachers in the I-Group are over age 36, this number jumps to 76 percent for teachers in the C-Group. This difference in ages is reflected in similar differences in teaching experience and technology training (Table 7), as may be expected.

Table 5

Percent Distribution of Teaching Experience in Both Groups

Group	Years in Education				
	<5	6-10	11-15	16-20	>20
I-Group	50	14	14	7	14
C-Group	6	12	41	18	24

Table 6

Percent Distribution of Teachers by Age, in Both Groups

Group	Age of Teachers				
	25-30	31-35	36-40	41-45	>45
I-Group	50	14	-	14	21
C-Group	-	24	12	35	29

Table 7

Percent Distribution of Technology Training Experience in Both Groups

Group	Hours of Technology Training				
	<15	16-30	31-45	46-60	>60
I-Group	71	21	7	-	-
C-Group	29	18	29	12	12

With regard to familiarity with PBL, the demographics of both groups differed (Table 8). Although teachers in the I-Group were younger and had less teaching experience than teachers in the C-Group, they appeared to have more familiarity with PBL. This may be attributed to the improved quality of teacher training programs, especially with respect to technology. Regarding goals relative to teaching and technology (before the ITEL training), that were ordered along the Apple Classroom of Tomorrow (ACOT) stages of technology integration (Sandholtz, et al. 1997, as cited in Oberlander, 2002), both groups responded similarly to the uppermost levels of technology integration, i.e. integrative (see Table 9). However, it is interesting to note that there is a significant increase from 42% (pre-test) to 71% (post-test) of teachers in the I-Group responding favorably to the uppermost levels of technology integration, i.e. integrative and new uses (Table 10). This may be attributed to the success of the ITEL training they received in the workshop.

Table 8

Percent Distribution of Teachers with Different Levels of Familiarity with PBL

Group	Familiarity with PBL			
	Unfamiliar	Little to no Understanding	Basic Understanding	Prior Experience
I-Group	14	29	36	21
C-Group	29	24	35	11

Table 9

Percent Distribution of Teachers' Personal Goals Before ITEL Workshop

Group	Personal Goals				
	Basic	Support	Productivity	Integration	New Uses
I-Group	7	36	14	43	-
C-Group	18	12	6	41	24

Table 10

Percent Distribution of I-Group Goals Before & After ITEL Workshop

I-Group	Personal Goals				
	Basic	Support	Productivity	Integration	New Uses
Pre-Test	7	36	14	43	-
Post-Test	18	7	14	57	14

In conclusion, the demographic comparison of the I-Group and the C-Group revealed that the I-Group teachers were younger, had fewer years of teaching experience, and less hours of technology training than the teachers in the C-Group. In contrast, the I-Group teachers had more experience with PBL than did the C-Group teachers. Despite these differences, both groups were similar in their goals relating to teaching and technology.

Analysis of the REI Survey

Descriptive statistics using the SAS statistical software program was used to analyze the REI. This was a post-test evaluation, analyzing the REI scores of the I-Group and comparing the mean score with that from the C-Group. The REI consisted of twelve paired words that described the ITEL workshop experience. Each word pair consisted of a REAL-associated word (assigned a numerical value of 7) and a word at the other end of the spectrum (assigned a value of 1) that described traditional directive teaching. On a discrete seven-point scale that separated these two extremes, participants selected a point (for each word pair) that best represented their experiences in the ITEL workshop. The sum of the 12 scores for each participant was then computed and the mean of these sums calculated for each group. A two-sample t-test was used to compare these means for the two groups. The sum of 12 scores for a participant can range from 12 to 84, with a high score indicating a greater association with a REAL-based professional development experience in the workshop.

The mean group scores were 68.0 for the I-Group (with score sums for the individual participants ranging from 50-77) and 65.2 for the C-Group (with individual sums ranging from 46-78). These data are reported in Table 11 and depicted in Figure 2. The pooled t-test results showed no statistically significant difference in these two group means ($p = 0.3807$; $t = -0.089$; $df = 29$). The high values of both means, however, relative to the theoretical range of 12-84, signifies that the overall experiences of teachers in both groups were more closely associated with a REAL experience than a directive teaching experience. Both groups confirmed that the environment that was provided in the ITEL workshop was indeed congruent with Grabinger's six constructs.

Table 11

REI Survey Statistics

Group	Number of Participants	Aggregate Score of Participants			
		Mean	Std. Dev.	Minimum	Maximum
I-Group	14	68.0	7.96	50	77
C-Group	17	65.2	9.40	46	78

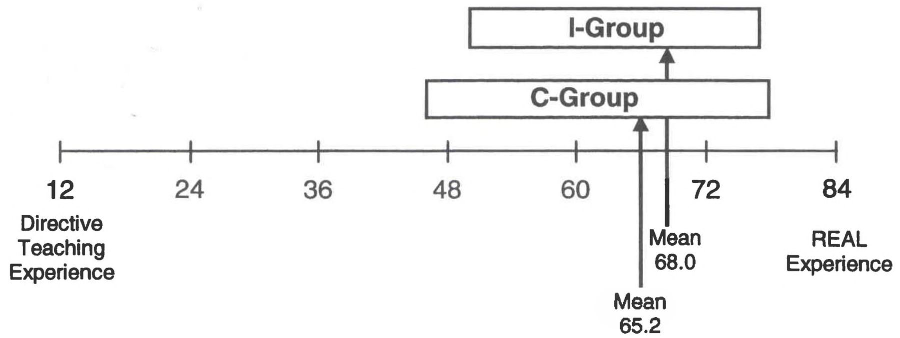


Figure 2. Pictorial Depiction of the REI Survey Results for Both Groups

Sub-analyses were performed on the REI data to investigate if teaching experience and prior knowledge of PBL had any influence on the mean REI scores. From Table 12 it is apparent that there is little variation in mean score with years of teaching experience, for either group, suggesting that teaching experience did not impact the REI results. In the second analysis (Table 13) teacher familiarity with PBL was divided into two categories: those that had no knowledge of PBL or had only heard about it, and those that had a basic understanding and/or some previous experience with PBL. The mean scores of those in the first category are similar for both groups. The greater difference in the group mean scores for teachers in the second category suggests that participants in the I-Group experienced a stronger sense of a REAL environment because of their familiarity with PBL and technology integration, although the t-test showed that the difference was not statistically significant. In summary, neither demographic variable impacted the mean scores within any group; therefore, years of experience as well as familiarity with PBL did not appear to influence responses to the REI survey.

Table 12

REI Survey Statistics Based on Years of Teaching Experience

Group	Years of Experience	Number of Participants	Aggregate Score of Participants			
			Mean	Std. Dev.	Minimum	Maximum
I-Group	< 10	9	67.4	9.85	50	77
	11-20	3	67.7	3.51	64	71
	> 20	2	71.0	1.41	70	72
C-Group	< 10	3	64.7	7.76	56	71
	11-20	10	65.7	11.81	46	78
	> 20	4	64.3	3.30	61	68

Table 13

REI Survey Statistics Based on Participants' Familiarity with PBL

Group	Familiarity with PBL	Number of Participants	Aggregate Score of Participants			
			Mean	Std. Dev.	Minimum	Maximum
I-Group	Little to none	6	64.8	10.96	50	75
	Understand and/or teach	8	70.4	4.10	64	77
C-Group	Little to none	9	67.3	3.57	62	72
	Understand and/or teach	8	62.8	13.23	46	78

Analysis of the RBI Survey

Both groups completed the REALs Beliefs Inventory (RBI). The I-Group completed this inventory twice, once before the ITEL workshop and a second time when the training was completed. The C-Group completed this inventory just once, at the conclusion of their ITEL workshop. This RBI was designed to survey teachers' beliefs relative to the six constructs of Grabinger's Rich Environments for Active Learning (Grabinger, 1996). The six constructs are constructivist influences, authentic learning, student responsibility and initiative, cooperative learning, generative learning activities, and authentic assessment. Four questions, two describing the REAL construct and two describing a directive teaching orientation represented each construct. This 24-item Lickert scale required the respondents to select the response that most closely matched their beliefs about teaching strategies and epistemology. Response choices were *strongly disagree*, *disagree*, *undecided*, *agree*, and *strongly agree*. Each response was assigned a numerical value from 1 to 5. Possible scores therefore ranged from 24 to 120, with a lower score representing a more constructivist epistemological orientation and a higher score representing a more directive teaching epistemological orientation. The SAS statistical software was used to conduct a comparative analysis using a t-test for paired samples from the pre-test and post-test RBI scores of the I-Group, and also a t-test for combined group statistics from the post-test scores for both groups.

Participants in the I-Group had a mean RBI score of 2.40 on the pre-test and 2.23 on the post-test, from a possible range of 1-5. These data are reported in Table 14 and depicted in Figure 3. A second analysis was performed to compare the post-test means of RBI scores from the I-Group (2.23) and C-Group (2.17), using a t-test for independent samples. The results, once again (see Table 15), showed no statistically significant difference between the means ($t = -0.64$; $p = 0.5294$; $df = 29$). Both these mean scores indicate, however, that the participants generally selected the "*agree*" response on the

Beliefs inventory, which signifies agreement with REAL constructs. In an effort to determine differences at the construct level of the RBI, a MANOVA was used. Mean scores at the construct level elicited no statistically significant differences between the scores by group (Wilks' Lambda = 0.7715; F = 1.18; 6, 24 df; p = 0.3476). In summary, the closeness of the means in both Tables 14 and 15 suggest that both groups had similar beliefs toward constructivism and problem-based teaching methodologies, while the ITEL workshop did not appreciably change the beliefs of teachers in the I-Group.

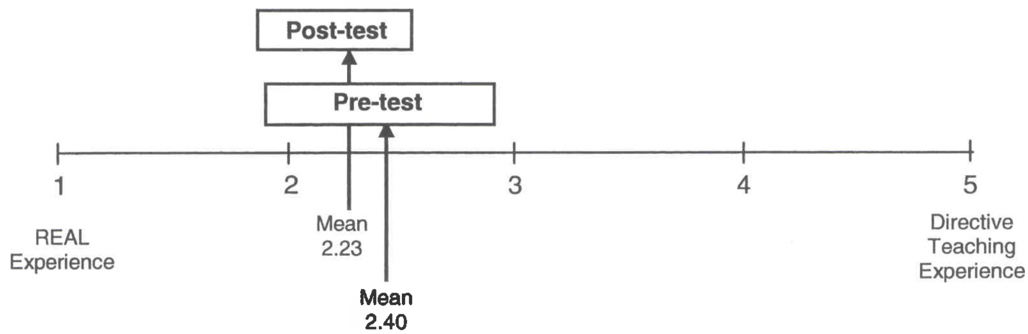


Figure 3. Pictorial Depiction of RBI Survey Results for the I-Group

Table 14

Paired Groups Statistics for I-Group RBI Scores

I-Group	Number of Participants	Mean	Std. Dev.	Minimum	Maximum
Pre-test	14	2.40	0.31	1.91	2.95
Post-test	14	2.23	0.21	1.87	2.54

Table 15

Combined Groups Statistics for I-Group & C-Group RBI Scores

Group	Number of Participants	Mean	Std. Dev.	Minimum	Maximum
I-Group	14	2.23	0.21	1.87	2.54
C-Group	17	2.17	0.30	1.54	2.58

Comparative Analysis of the Self-Assessment Survey (SAS)

Both groups were administered the SAS upon completion of the ITEL workshop. This survey rated the effectiveness of the workshop on the participants in direct proportion to their perception of PBL knowledge gained and technology skills learned. It required participants to respond to six statements, three of which were related to PBL (knowledge, design and facilitation of a PBL unit) and three to technology integration (technology skills, purposes of classroom technology, and new ideas in technology integration). The survey was a Lickert-scale assessment with a five-point continuum from *strongly disagree* (1point), *disagree* (2 points), *undecided* (3 points), *agree* (4 points) to *strongly agree* (5 points). The group mean score (mean of the participants' mean scores for the six SAS responses) was 3.92 for the I-Group and 3.88 for the C-group (Table 16). Superimposed on the Lickert scale, these means fall between 3 and 4 (closer to 4), or between *undecided* and *agree*. This implies that the participants, in general, either agreed or were undecided on whether they had achieved the desired goals of the ITEL workshop.

Table 16

Combined Groups Statistics for I-Group & C-Group SAS Scores

Group	Number of Participants	Mean	Std. Dev.	Minimum	Maximum
I-Group	14	3.92	0.79	2.16	5.00
C-Group	16	3.88	0.84	2.16	4.83

A sub-analysis of the group mean scores was performed relative to PBL and technology integration, to gain insight into the extent to which the I-Group participants experienced personal growth in these areas. The results are displayed in Table 17.

Table 17

Statistics of SAS Scores Relative to PBL and Technology Integration

Group	Variable	N	Mean	Std. Dev.	Minimum	Maximum
I-Group	PBL	14	3.71	1.19	1.00	5.00
	Tech. Int.	14	4.14	0.56	3.33	5.00
C-Group	PBL	16	3.85	0.99	1.66	5.00
	Tech. Int.	16	3.91	0.82	1.66	5.00

From the table it can be seen that the mean scores (for both groups) relative to PBL are lower than those relative to technology integration, indicating that the teachers had a greater sense of personal growth related to technology integration as compared to problem-based learning. It also appears that this sense of growth in the area of technology integration was greater in teachers from the I-Group (mean score 4.14) as compared to teachers from the C-Group (mean score 3.91).

Subjective Analysis of the Open-Ended Questionnaire

The open-ended questionnaire, consisting of five questions, was administered only to the I-Group, upon their completion of the ITEL workshop. This gave participants an opportunity to reflect on their yearlong experience with the workshop and provide feedback, summarizing their training experience, its application in their classrooms, their teaching and learning goals relative to creating a PBL unit, and suggestions for improvement. The responses are summarized below, with details shown in Appendix D.

1. Would you recommend this workshop to a colleague? Why or why not?

Three participants said "No," with reasons related to learning style and discomfort with the autonomous role that is significant for a student participating in the PBL process. Another reason was the open-ended format that appeared to lack structure and direction. This led to a disconnect in the learning experience of one participant who expressed that no knowledge of creating a PBL unit was imparted in the workshop. Eleven participants said "Yes," they would recommend the workshop to a colleague. Reasons for this included:

- satisfaction of having learned enough about technology to use the school's resources more effectively
- increasing knowledge and functionality to the point of being more comfortable with technology
- an abundance of information obtained on the use of technology as a classroom tool
- valuable learning of problem-based strategies; opportunity to collaborate with peers

- acquisition of new ideas and skills, providing the opportunity to grow teacher knowledge of technology while simultaneously applying these new skills in the classroom to enhance student learning

2. List five words that describe your experience in the yearlong ITEL workshop

The following words were used to describe the ITEL workshop experience:

Accomplishment	Determination	Fun	Open-Ended	Shocked
Alternative	Discovery	Growth	Organized	Stimulating
Anxiety	Disjointed	Helpful	Pride	Stressed
Applying	Enhancing	Imagination	Proficient	Supportive
Captivating	Enlightened	Improvement	Provoking	Team-based
Challenging (2)	Entertaining	Insightful	Relief	Tenacious
Collaborative	Excited	Interesting	Rewarding	Tiring
Confusion (7)	Freedom	Investigating	Self-learning	Unclear
Cooperative (2)	Frustrating (4)	Invigorating	Self-satisfying	Undecided

These words aptly summarize the PBL experience of learners in a technology-enhanced environment. They encompass the essence of a learner experience immersed in a PBL context using technology as "mindtools."

3. Do you plan to develop a PBL unit for use in your classroom? Explain.

Twelve teachers planned to complete a PBL unit and turn it in to add to ITEL's collection of PBL teacher resources. The reasons for this decision included:

- being able to enhance the use of existing materials designed for PBL to better suit students and their learning
- belief that the techniques and strategies involved with PBL facilitate better learning on the part of students, which leads to higher long-term retention
- belief that it is a useful tool in the classroom, and students will benefit from exposure to a PBL setting

- excitement from the Grizzly Bear unit that generated enthusiasm to develop a PBL adventure
- belief that collaboration with a peer to produce a PBL unit would be beneficial to student learning and personal growth
- the monetary incentive of $600

The remaining two teachers were unsure due to the time involved and a lack of understanding on how to design a PBL unit.

4. How did the ITEL program impact your teaching practice during this academic year?

The responses suggested effective transfer of newly acquired knowledge of PBL and skills in technology integration into the classroom. The responses demonstrated technology integration in the following ways:

- Increase in the use of available technology resources in the schools
- Increase in the use of the Internet as a classroom resource
- Giving students the freedom to choose their own projects and decide how and what they would like to learn
- Customizing technology resources to suit classroom needs
- Increased use of cooperative learning strategies as a result of renewed trust in its academic value
- Assisting other teachers in their use of technology
- Being forced to venture out of their technology comfort zone and be viewed as a student as well as a teacher
- Engaging students actively in the learning process through the use of technology
- Discovery of new software and web capabilities and setting of goals to use PowerPoint more effectively

- Willingness to give students the freedom to develop a project without micromanaging

5. What are your recommendations for improving the ITEL workshop for the next year?

Responses to this query provided valuable insights about the difficulties experienced by the participants. Recommendations included the following:

- Ensure that the cooperative groups create or work on something at each meeting to enhance their project. The bulk of the work was completed in the last month.
- Keep the meetings off-campus as much as possible because of inadequate parking on campus
- A specific agenda for meetings
- More focus. There was a lot of energy and ideas, but more could have been accomplished in the allotted time
- Devote more class time to the group project (maybe add a session)
- Assist students in identifying technical skills that they have, and will need for the final project, at the start of the workshop
- The need for PBL to have a messy problem, question or situation is understood. But, because of "life" (families, work, time, etc.) a little more organization or focus is necessary
- Have participants develop a PBL unit, not write lesson plans. Be better prepared for class sessions and actually teach participants how to do things, such as create a web quest
- Minimize changes in meeting times and locations. Perhaps participants could receive more college credit for this workshop.

- Increase in-class time for cooperative group collaborations. When the ideas are still fresh and participants are focused on the issue at hand, implementation is more likely.
- The year-long workshop may be characterized as "a strong opening, weak middle, strong closing." The workshop lacked direction in the middle months.
- Do not have individual groups work towards a big question posed and then have groups support the question. The format is difficult.

These responses provided invaluable insights into the effectiveness of the ITEL professional development program that could not have been gained from Lickert scale responses to set questions on a survey.

CHAPTER V

SUMMARY, CONCLUSIONS, IMPLICATIONS,

& RECOMMENDATIONS FOR FURTHER RESEARCH

Summary

A dramatic increase in affordable computing power and the rapid growth of the Internet in the past few years have fundamentally transformed the way we live and work. American education is at a turning point. Research during the last two decades has shown that technology, when used effectively, brings relevance, motivation and deep meaning to student learning in ways never before possible. The research studies referenced throughout this document show that teachers are the key to advancing student learning through technology. Administrators play a big role too, but the heart of it lies with the teachers. Moursand & Bielefeldt (1999) voiced their concern in the policy debate on school technology by posing the question, "What changes must take place in public schools to ensure that all youngsters will be adequately prepared to live, learn and work successfully in this digital age?" In seeking an answer to this question this study delved into the processes of designing effective professional development training to impact teachers' beliefs and attitudes towards a Problem-Based Learning (PBL) approach to technology integration. It sought to impart knowledge about PBL and model the steps in its implementation for teachers to experience, so that they would be more apt to use it in their classrooms. After experiencing a range of feelings, from dissonance to elation, themselves, they were sensitized to what students may experience in the PBL process. This study was conducted by the Institute for Technology-Enhanced Learning

(ITEL) at the University of Dayton. Funded in part by an Ohio Learning Network grant awarded to ITEL, this training program developed from a partnership between ITEL and three partner schools. As part of this initiative, ITEL worked in conjunction with the partner schools to create this experiential Problem-Based Learning model, that strategically combined the new electronic tools of today with a problem-based learning approach, to enhance the ability of students to actively participate and have a stake in their own learning. This study built on a previous one-year study (Oberlander, 2002) in the 2000 - 2001 school year on ITEL's implementation of this model with a pilot group of teachers from the same partner schools. The results from this study are sought to aid the university trainer and the technology coordinators in gauging the effectiveness of this professional development model for technology integration while meeting the needs of learners today.

The subjects for this study were 14 self-selected in-service teachers (the intervention group) who received the training from ITEL during the 2001 - 2002 school year, and the 17 in-service teachers from the same partner schools that received the training in the 2000 - 2001 school year (the comparison group).

The researcher was an observer that chose to pursue this study to gain a thorough understanding of PBL (first-hand knowledge of the processes involved in its planning and implementation), developing a technology-enhanced environment, the role of the teacher (trainer/coach/facilitator), and role of the student. By being immersed in the process the researcher could provide rich descriptions of the sessions to enhance understanding of the workshop design. Quantitative data was collected while using a mixed-method design for the study.

Instrumentation included a total of five instruments, including two Lickert-scale inventories referred to as the Self-Assessment Survey and a REAL Belief Inventory, a semantic differential survey called the REAL Environmental Inventory (REI), a

Demographic Survey, and an Open-Ended Questionnaire. A pre-test/post-test design was used to report changes in teacher beliefs and attitudes using the REAL Belief Inventory (RBI), consistent with Grabinger's (1996) Rich Environments for Active Learning contexts. In addition teachers were asked to commit to turning in PBL units demonstrating their use of the ADISC model to integrate technology into their classroom practice. Post-test scores on the RBI of the intervention group were also compared with post-test scores of the comparison group, to determine gains due to environmental changes.

The REI was designed to help participants rate their experience of the environment in the ITEL training program from that of a directive teaching experience to a more constructivist teaching experience. Although the results were not statistically significant it may be implied that the I-Group had a slightly stronger sense of experiencing a REAL-associated environment than the C-Group. With a mean score of 68.0 for the I-Group and 65.2 for the C-Group, it may be concluded that both groups were very similar in the way they experienced the environment, and the overall experience of the teachers in both groups were more closely related to a REAL-associated environment than a directive teaching environment. From a sub-analysis of the REI using the demographic variables of years of teaching experience and familiarity with PBL, it can be concluded that neither of these variables had an impact on the results of the REI.

Both groups completed the REAL Beliefs Inventory (RBI). The RBI was designed to survey teachers' beliefs relative to the six constructs of Grabinger's (1996) Rich Environments for Active Learning (REAL). In summarizing the results of the RBI although there were no statistically significant differences between the two groups' mean scores and the pretest and the posttest of the I-Group, we can still surmise that both the groups were highly similar in their beliefs and favorably disposed towards constructivist and problem-based teaching methodologies.

The SAS survey rated the effectiveness of the workshop on the participants in direct proportion to their perceptions of PBL knowledge gained and technology skills learned. It was observed that relative to the PBL variable, the I-Group teachers' and the C-Group teachers' mean scores indicate they were unsure about their sense of personal growth in this area. On the technology variable, however, the mean score for teachers in the I-Group indicated that they agreed that they had grown in the area of technology integration, more so than teachers in C-Group, whose mean score reflected some doubt about their personal growth in this area.

The Open-Ended Questionnaire gave the participants an opportunity to reflect on their yearlong experience in the ITEL training program and to provide detailed feedback. Results from this questionnaire provided invaluable insights into how the workshop was impacting their classroom practice; 12 out of 14 participants indicated that they would develop and turn in PBL units; 12 out of 14 participants also indicated that the workshop had favorably impacted their classroom practice. Their summaries of their experiences showed that they had experienced an authentic PBL learning context from the students' perspective. Their recommendations for improvement of the professional development program provided excellent ideas for incorporation into next year's program. Most of these suggestions centered on taking into consideration the fact that they were adult learners. They would also have liked to see a more efficient use of time at each session, and work on the collaborative project begin earlier in the year, rather than in the last two sessions.

Conclusions

The findings from this research study have led to the following conclusions regarding the role of the professional development environment in impacting teachers' beliefs on using PBL as a vehicle to effectively integrate technology into their classrooms.

- From the SAS and Demographic survey, it may be concluded that younger teachers today, although less experienced, are slightly more apt to be pre-disposed to the use of technology in the classroom. From the observations, however, it was evident that both groups, regardless of age or teaching experience, were turned on by the PBL experience and the new ideas gained on technology integration.
- From the responses to the Open-Ended Questionnaire it may be concluded that, regardless of variations in the demographics, the technology-enhanced constructivist-based, problem-based learning environment of ITEL's professional development workshop in some way impacted most teachers (12 out of 14) from the intervention group. This was obvious in their reports of how they were doing things differently in the classroom, for example with the use of cooperative groups (after gaining a new trust in the academic value of PBL), reaching a new comfort level with giving students more freedom to choose the direction of investigations and assessments, being comfortable with students viewing the teacher as a "student", using the Internet more effectively, and using mind-mapping software as a conceptual, collaborative tool.
- Despite the success of the Open-Ended Questionnaire, the results from the REI, the RBI, and the SAS are not similar. One shows that the change in environment made no significant difference in the teachers' beliefs, while another shows examples of self-reported practice that does document problem-based learning components and a significant increase in the manner in which technology is integrated as mindtools. This may require taking a closer look at the instruments

designed for this study to see if they are effectively measuring the changes or impact on teacher beliefs in its authentic learning context.

- From the results of the comparisons made between post-test scores of both groups on the REI, the RBI and the SAS, it may be concluded that though they are not significantly different, the absolute values indicate that the workshop had the same degree of effectiveness on both groups. This may mean that the change in the group design (to grade-level groupings as compared to mixed grade levels in the previous study) or the difference in the end product (creation of a CD-ROM as compared to a simulation) made no difference to the overall effectiveness of the environment on teachers' beliefs.

Implications for Practice

This study has significant implications for the staff development team from the University of Dayton, the Technology Coordinators from the participating partner schools, classroom teachers, school administrators and community stakeholders. The implications for each are reported below.

Implications for Staff Developers

This study promotes the use of a newly developed model that strategically combines the new electronic tools of today with a problem-based learning approach to enhance the ability of students to actively participate and have a stake in their own learning. The previous study by Oberlander (2002), and the current work contribute to the research-based foundations of this model. This study also documents the effectiveness of this model and creates awareness in the school communities of the manner in which PBL can be used to effectively integrate technology, a goal that all schools are striving to achieve. In addition it provides feedback that allows staff developers to make the necessary changes to improve the program for the upcoming school year.

Implication for Technology Coordinators

For technology coordinators, whose job is to support the integration of technology into the classroom, this research study offered hands-on training and experiential learning through their close involvement with the ITEL staff developers on how to put this teaching-learning paradigm into action. Their involvement is critical to making this approach a long-term success in the schools.

Implications for Classroom Teachers

Research has consistently shown the need for classroom teachers to change their practice from traditional teaching methods to more constructivist methods to support the changing needs of students in today's technologically advanced environments and to better prepare them for the challenges of their future work place. ITEL's training program offers teachers a tangible way to promote such change. The continued support provided by the university and the technology coordinators from the partner schools make this a very achievable goal for the teachers and a reason to want to be a part of this program. This research study provides insights to classroom teachers about PBL and technology integration, and examples of the effects of the ITEL training on teaching practice in the classroom.

Implications for Administrators

With the increasing pressure of accountability to stakeholders in the educational process, administrators have to clearly articulate rationales for their expenditures on technology enhancements in schools. Professional development strategies for staff to effectively integrate technology into the classroom have been few and far between. As

Oberlander (2002) points out, the ADISC model (described by Lasley, et al., 2000, and used in both Oberlander's and this study) offers a powerful conceptual framework to guide principals and central office administrators in clearly articulating the specific ways in which technology can be represented as "mindtools" for enhancing teaching and learning. It also aids in proper preparation of students to work in a technologically advanced workplace setting. The results from the current and previous research studies using the ITEL professional development program provide a rich resource for administrators to determine the effectiveness of this program.

Implications for Community Stakeholders

Problem-based learning puts the context into teaching methodologies that otherwise make no connection with the real world. Students are constantly asking, "Why do I have to learn this?" PBL forces teachers to make the connections between the curriculum and its applications to the real world. Community resources have to be tapped, and students have to be given more opportunities to interact with community members and gather information from services and resources they provide through personal or online collaborations, to make informed decisions on meaningful "problems" (relevant issues). This study demonstrates to the public how teachers are effectively using the technology resources the schools provide to enhance student learning and encourage student and community interactions.

Recommendations for Future Research

This study chose to explore the effects of a change in the learning environment of a professional development workshop on the attitudes and beliefs of classroom teachers. Specifically, what were the effects of a Problem-Based Learning approach to technology integration using a technology-enhanced learning environment, on the beliefs and attitudes of classroom teachers? In the process, valuable insights were gained on problem-based learning and technology integration from different perspectives – the trainer's, the technology coordinators', and the classroom teachers' (as adult learners). The personal growth achieved by the researcher through the process of writing this thesis has been tremendous and will have a profound effect on the researcher's own teaching practice. Based on the results of this study and observation of, and interaction with teachers at, the training sessions, the following recommendations are made to enhance the effectiveness of ITEL's professional development model for technology integration in the long-term.

- Conduct a follow-up study with the technology coordinators that have been consistently involved in the ITEL project from its inception, to find out how they supported the teachers in the classroom to continue using PBL as an approach to effective technology integration.
- Conduct a follow-up study on the first and the second batch of ITEL teachers that completed the training to see how it has impacted their classroom practice on a regular basis. Included in the study could be questions such as: Have the teachers developed any more PBL units since the first one? Have they implemented more than one PBL unit? What are the reactions of the students to use of PBL methodologies? How has their classroom environment been impacted since their ITEL experience?
- Perform an in-depth analysis of the instruments developed for measuring teacher attitudes and beliefs that were used for this study; specifically, the RBI, and the REI need to be re-evaluated to gain a reassurance of their effectiveness.

APPENDIX A

SURVEY INSTRUMENTS USED TO DETERMINE CHANGES IN TEACHER BELIEFS AND ATTITUDES

Demographic Survey

For each of the following items, please select one letter that best answers each question from your perspective:

1. How many years have you worked in the field of education?

   A. 5 years or less
   B. 6-10 years
   C. 11-15 years
   D. 16-20 years
   E. 21 or more years

2. **Prior** to your involvement with the ITEL program, approximately how many **hours** of technology training have you attended in the past 5 years? (including CEU courses, graduate classes, and other training events)

   A. 15 hours or less
   B. 16-30 hours
   C. 31-45 hours
   D. 46-60 hours
   E. 61 or more hours

3. Which of the following categories contains your current age?

   A. 25-30
   B. 31-35
   C. 36-40
   D. 41-45
   E. 46 and above

4. Which of the following best describes your knowledge of Problem-Based Learning **prior** to participation in the ITEL program?

   A. I was unfamiliar with the term *Problem-Based Learning.*
   B. I had heard the term *Problem-Based Learning,* but did not really understand it.
   C. I had a basic understanding of *Problem-Based Learning.*
   D. I had previous experience with using PBL in my classroom.

5. **Before** the ITEL training, which of the following statements would have best described your personal goals relative to teaching and technology:

    A. Increasing student productivity by using technology
    B. Learning the basics of new technology
    C. Discovering new uses for technology
    D. Focusing on cooperative, project-based and interdisciplinary work, using technology, as needed
    E. Using technology skills to support traditional instruction

6. **After** the ITEL training, which of the following statements would have best described your personal goals relative to teaching and technology:

    A. Increasing student productivity by using technology
    B. Learning the basics of new technology
    C. Discovering new uses for technology
    D. Focusing on cooperative, project-based and interdisciplinary work, using technology, as needed
    F. Using technology skills to support traditional instruction

Please continue to next page

REALs Environmental Inventory (REI)

For each of the following items, check a box in each row that most closely describes your experiences in the year-long ITEL professional development program.

	A	B	C	D	E	F	G	
7. Realistic	☐	☐	☐	☐	☐	☐	☐	Unrealistic
8. Project-based	☐	☐	☐	☐	☐	☐	☐	Textbook-based
9. Teacher as presenter	☐	☐	☐	☐	☐	☐	☐	Teacher as facilitator
10. Collaborative	☐	☐	☐	☐	☐	☐	☐	Individualistic
11. Artificial	☐	☐	☐	☐	☐	☐	☐	Authentic
12. Active	☐	☐	☐	☐	☐	☐	☐	Passive
13. Self-directed	☐	☐	☐	☐	☐	☐	☐	Teacher-directed
14. Traditional assessment	☐	☐	☐	☐	☐	☐	☐	Alternative assessment
15. Self oriented	☐	☐	☐	☐	☐	☐	☐	Team oriented
16. Teacher-centered	☐	☐	☐	☐	☐	☐	☐	Student-centered
17. Static	☐	☐	☐	☐	☐	☐	☐	Fluid
18. Performance-based test(s)	☐	☐	☐	☐	☐	☐	☐	Pencil/paper test(s)

Please continue to next page

REALs Belief Inventory (RBI)

For each of the following items, indicate your degree of agreement with each of statement by bubbling in the letter that best represents your response.

19. Students learn best when given the opportunity to make personal meaning of new ideas and experiences.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
A	B	C	D	E

20. Having students work in cooperative groups is unfair to students who are motivated and responsible.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
A	B	C	D	E

21. Student understanding is best measured by traditional quizzes and tests.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
A	B	C	D	E

22. Students learn best when they acquire knowledge that is embedded in real-world problems and issues.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
A	B	C	D	E

23. Student understanding is impeded when students are asked to make sense of alternate points of view.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
A	B	C	D	E

24. Working in peer groups helps students develop the social skills necessary to function effectively in real world work environments.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
A	B	C	D	E

25. Students often lose motivation when asked to think about realistic problems because they are too complex.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
A	B	C	D	E

26. Students should not be asked to think about a problem requiring higher-order thinking until they have mastered basic skills.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
A	B	C	D	E

27. Students should help establish the criteria on which their work will be assessed.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
A	B	C	D	E

28. Allowing students to teach each other can be dangerous because it often leads to students learning the wrong things.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
A	B	C	D	E

29. Knowledge is not a product to be achieved, but a process to be pursued.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
A	B	C	D	E

30. Using authentic assessment strategies is not a time-efficient method of evaluating student understanding.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
A	B	C	D	E

31. Students are more likely to transfer knowledge if they have learned it from a teacher who presented it in an organized structure.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
A	B	C	D	E

32. Groups help students gain insights and understandings that would not come about individually.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
A	B	C	D	E

33. Quality learning is anchored in a specific context.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
A	B	C	D	E

34. Effective teachers should have expertise in any content they ask their students to study.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
A	B	C	D	E

35. Students should be given opportunities to demonstrate their understanding in multiple ways.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
A	B	C	D	E

36. Learning is enhanced when students share their thinking processes publicly.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
A	B	C	D	E

37. Students are capable of regulating their own learning processes.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
A	B	C	D	E

38. Teachers should respect a student's right to keep their thought processes private.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
A	B	C	D	E

39. Good tests stress depth more than breadth.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
A	B	C	D	E

40. Students achieve deeper understanding when asked to consider alternate viewpoints on complex issues.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
A	B	C	D	E

41. Teachers should clearly define any problem that is the focus for a Problem-Based Learning unit before asking students to seek a solution.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
A	B	C	D	E

42. Teachers should be solely responsible for determining the standards by which students are assessed.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
A	B	C	D	E

Please continue to next page

Self-Assessment Survey (SAS)

43. Participation in the ITEL program has increased my knowledge of Problem-Based Learning theory.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
A	B	C	D	E

44. Participation in the ITEL program has provided me with the skill to design a Problem-Based Learning unit.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
A	B	C	D	E

45. Participation in the ITEL program has provided me with the skill to facilitate a Problem-Based Learning unit.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
A	B	C	D	E

46. Participation in the ITEL program has provided me with new skills in technology.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
A	B	C	D	E

47. Participation in the ITEL program has helped me clarify my personal theories on the purposes of classroom technology.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
A	B	C	D	E

48. As a result of participation in the ITEL program, I have acquired new ideas regarding integrating technology in the instructional design process.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
A	B	C	D	E

Thank you for your time !

Open-Ended Survey for 2001-2002 Participating ITEL Teachers

***All information including your name will be held confidential**

Participant Name: ______________________________

1. Would you recommend a colleague to become involved in next year's ITEL program (similar to what you experienced this year)?

   Please circle your answer : *YES* *NO*

   Briefly describe your reason for this answer.

2. Please list 5 words (not phrases) that describe your experience in the year-long ITEL professional development program you have just completed.

3. At this time, do you plan to develop a PBL unit for use in your classroom?

   Please circle your answer - *YES* *NO* *UNSURE*

   Please explain your reason for this answer.

4. Briefly describe any way in which the ITEL program may have impacted your teaching practice during this academic year.

5. Briefly describe any recommendations you might have for improving the ITEL professional development program for next year

APPENDIX B

THE ILL-STRUCTURED PROBLEM FOR THE PBL EXPERIENCE:

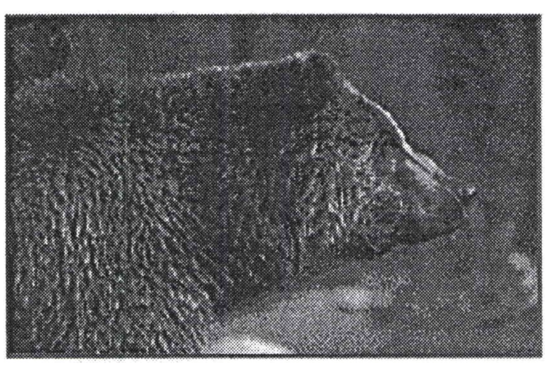
"GRIZZLY BEAR – LIVING SYMBOL OF THE AMERICAN WILDERNESS"

ITEL

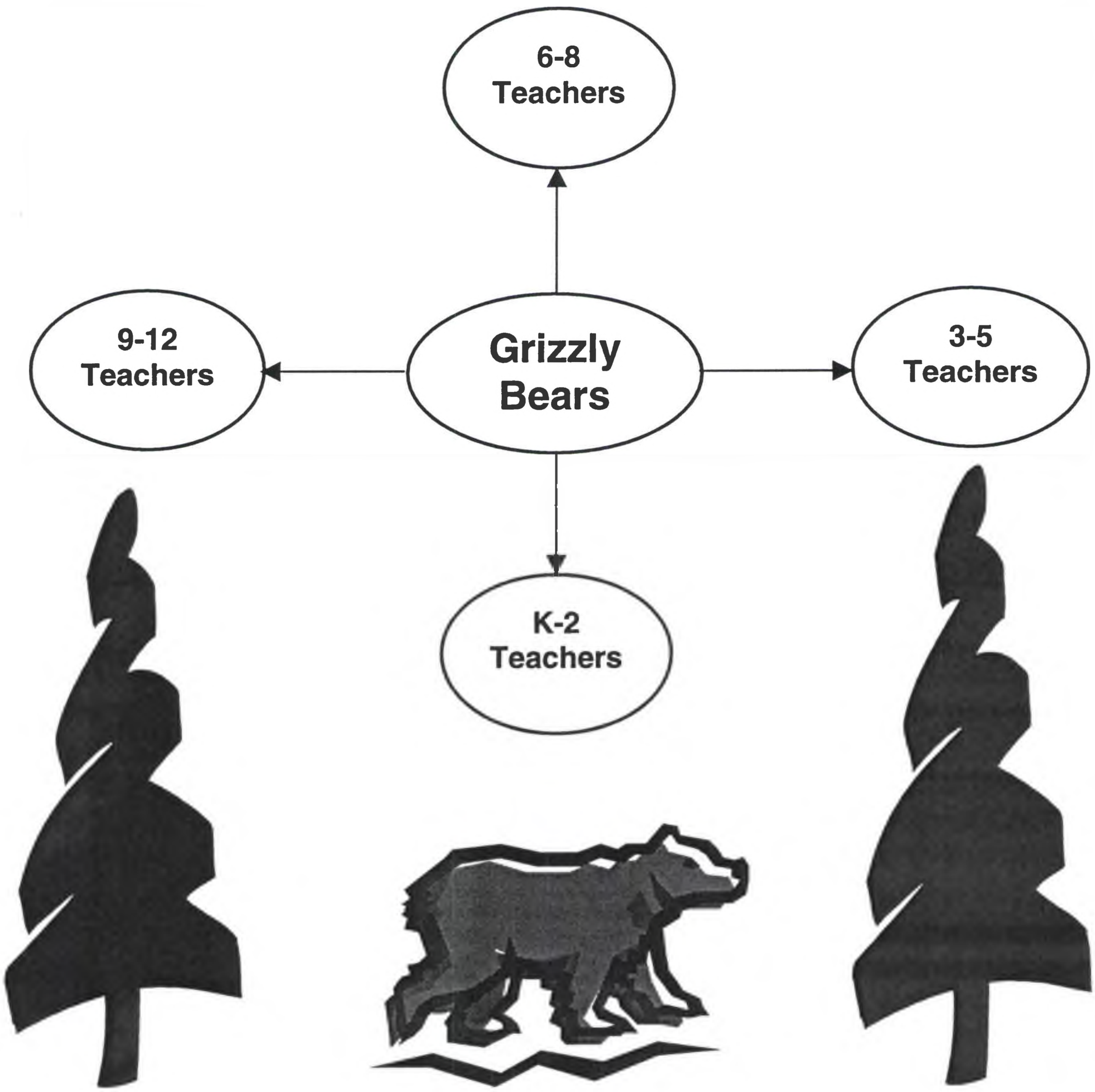
Teaching & Learning with Technology

A Workshop Developed By:

The Institute for Technology-Enhanced Learning



How can teachers develop a developmentally appropriate PBL unit of instruction that is enhanced by appropriate applications of technology?



Grizzly Bear

Living Symbol of the American Wilderness

A Multimedia Introduction to Problem-Based Learning

Designed and Developed by the Institute for Technology Enhanced Learning (ITEL) in Collaboration with the Teachers of the ITEL Partner Schools

Group/Individual(s): ______________________________

Grade Level(s): ______________ Subject (s): ______________

Instructional Goal ______________________________

____

Objectives:

1] ______________________________

2] ______________________________

3] ______________________________

4] ______________________________

Connection to Standards: *Briefly describe how the above are connected to appropriate local or state standards*

Instructional Sequence *(Briefly describe what students will do as they engage this learning experience).*

1]

2]

3]

4]

Student Technology Use: *(Briefly describe how students will utilize technology to enhance their learning in this activity).*

Multimedia Materials Utilized: *(List the kinds of multimedia (print, video, audio) resources students will interact with in this activity).*

Technical Support Needed: *(Briefly describe what help you need in managing the multimedia resources you would like to utilize).*

Grizzly Bear

Living Symbol of the American Wilderness

A Multimedia Introduction to Problem-Based Learning

Designed and Developed by the Institute for Technology-Enhanced Learning (ITEL) in Collaboration with the Teachers of the ITEL Partner Schools

Timeline

February 13	Group proposals sheet completed
March 14	Group progress reports
April 16	Group demonstration

Project Design Parameters

1. The activity engages students in a PBL learning experience. In other words, the activity asks students to solve a messy or ill-structured problem that does not have a singularly correct answer.

   Note: This does not suggest that the activity shouldn't require students to demonstrate knowledge or skill in specific academic areas such as mathematics, language usage, etc. (See # 4)

2. The activity requires students to interact with multimedia resources stored on the CD or accessible via the World Wide Web.

3. The activity requires students to make use of one or more forms of technology as represented on the ADISC framework.

4. The activity requires students to demonstrate knowledge or skills through an authentic or performance-based assessment anchored to a set of assessment rubrics created on the Rubistar web site (http://rubistar.4teachers.org/).

5. The activity is designed to help students develop knowledge and skills that are connected to state or district competency standards.

APPENDIX C

DATA ANALYSIS PROCEDURES FOR THE SURVEY INSTRUMENTS

PROCEDURAL DESIGN OVERVIEW OF STATISTICAL ANALYSES

Main question: What were the changes evidenced in **teacher attitudes towards PBL** upon completion of ITEL's REALs-based, 2nd-year, technology-enhanced workshop with changes in cooperative group design and delivery of final product?

Group 1 = I (intervention)-Group Group 2 = C (comparison)-Group
Numbers on the side indicate statistical operations run. Each number corresponds to a specific operation.

Research Questions	Instrumentation	Importance to project	Statistical Analysis
1. In what way did the ITEL workshop that was designed to simulate a REALs environment impact teacher attitudes? 2. What was the impact of the demographic variables: Years of experience and the current grade levels the teachers are teaching, on the teachers' attitudes in relation to their involvement in a REALs professional development experience? 3. How did the attitudes of the teachers in the I group compare with the attitudes of the teachers in the C group regarding the relationship to their involvement in a REALs professional development experience?	REI (REALs Environmental Inventory) from I-Group [and possibly also the training evaluation data] REI (REALs Environmental Inventory) from I- and C-Groups	▪ Provides insight about the extent to which veteran teachers experienced a REALs environment that they were being trained to create in their own classrooms ▪ Provides insight on the correlation between demographics and attitudes ▪ Compares and contrasts significant differences, if any, within the groups, to see if the changes in design and implementation impacted teacher attitudes.	▪ Total instrument score for each teacher ▪ Mean instrument group scores [REI Total Group] ▪ Sub-group means for A & B, C & D, and E on Q1(# of yrs. Of experience) of Part I Demographics from survey ▪ sub-group means for A & B and C & D on Q4 (grade level) of Part I Demographics from survey ▪ t-test for independent samples to compare the means of the 2 groups STATS: group means, SD, min, max

Note: I-Group = Intervention group; C-Group = comparison group

Research Questions	Instrumentation	Importance to project	Statistical Analysis
4. What were the self-perceptions of teachers regarding their personal growth in knowledge and skill relative to PBL and technology integration? 5. Were there any significant differences in the self-perceptions of teachers in the I group when compared with those of the teachers in the C group?	Self-Assessment Survey from I-Group SAS from I-Group vs. SAS from C-Group	▪ Provides insight on the extent to which the Group I teachers possessed a personal sense of growth relative to the identified variables ▪ Compares and contrasts any significant differences if any, within the groups. to see if the changes in design and implementation impacted teacher self-perceptions.	Analyze data from items 43-48 as subsets of data: ▪ Set 1 = PBL growth [on survey: #43-45; data items: S1-S3] Set 2 = Technology growth [on survey: #46-48; data items: S4-S6]; ▪ Please compute (with A=1, B=2, C=3, D=4, and E=5 o an overall total instrument score for the SAS instrument (on survey: items # 43-48; data items: S1 – S3) by individual o total means for all 14 of the individuals in group I on the SAS o repeat this same process for subtest #1 PBL growth (on survey: #43-45; data items: S1-S3) and for subtest #2 Technology growth (on survey: #46 – 48; data items: S4-S6 o re. subtest #2, create a scatterplot of the mean of subtest #2 scores plotted against the levels in Q5 [data item D6 (goals relative to teaching and tech.)] of Part I Demographics with A=3, B=2, C=5, D=4, and E=1 o ALSO: calculate the mean group scores on subtest #2 with group 1 = those who answered A, B, or E and group 2 = those who answer C or D STATS: Group means, individual teacher means by question, group means by PBL and Tech • Recommendations for Statistical Analysis procedures to compare both groups

Note: I-Group = Intervention group; C-Group = comparison group

Research Questions	Instrumentation	Importance to project	Statistical Analysis
6. What were the differences in the beliefs of I-Group and C-Group teachers regarding teaching practices, consistent with REALs learning contexts? 7. What were the differences in the beliefs of Group I before and after the ITEL workshop regarding teaching practices consistent with REALs learning contexts?	RBI (REALs Beliefs Inventory) from I-Group & C-Group RBI (REALs Beliefs Inventory) from Group I	▪ Provides insight on the comparative beliefs of 2 groups of teachers with one group having experienced the ITEL Partnership Schools Workshop with a change in group design and final delivery (I) while the other experienced the ITEL workshop last year in its pilot stage (C) ▪ Provides insight on the beliefs of the intervention group of teachers before having experienced the ITEL Partnership Schools Workshop and after having experienced the ITEL workshop, to see if there were any significant changes.	▪ Determine the internal consistency [reliability] of the RBI, perhaps using Cronbach's Alpha test with an alpha set at .05, using the combined groups of I and C [I-Group = data category: Gr, data items: 1; Group C = data category: Gr, data items: 2] ▪ Mean instrument scores of RBI for each group ▪ t-test of significant difference for independent samples and paired samples to determine whether there are notable differences between the beliefs of Groups I pre- and post-test, and Group I post-test and Group C post-test at the total score level of analysis ▪ Scores for Groups I and C, analyzed at the construct level, i.e. we want to know if there are significant differences on the sub tests (using MANOVA) for the 6 variables of: o Constructivism o Authentic learning contexts o Student responsibility o Cooperative learning o Generative learning activities o Authentic assessment STATS: ▪ Cronbach's Coefficient Alpha on Beliefs procedures ▪ Group means on Belief ▪ t-test of equal variance (pooled) for Groups ▪ Combined group means of constructs forming beliefs ▪ MANOVA on the constructs of the Beliefs, using Wilks Lambda

Note: I-Group = Intervention group; C-Group = comparison group

Research Questions	Instrumentation	Importance to project	Statistical Analysis
8. In what ways were Group I and Group C similar or dissimilar in light of a range of demographic variables?	Demographics from I-Group & C-Group	▪ Establishes the similarity of the two groups which becomes important as generalizations are made relative to the variables of interest [age; experience; prior tech training; grade level assignment; etc.] ▪ The following variables are similar: Both groups came from the same three schools; Both groups self-selected into the ITEL program.	▪ Frequency counts for the responses for both groups [I-Group = data category: Gr, data items: 1; Group C = data category: Gr, data items: 2] following item numbers: - years in education [data item: D1] - hours of tech training [data item: D2] - age [data item: D3] - grade level assignment [data item: D4] - PBL knowledge [data item: D5] - personal teach/tech goals [data item: D6] - compare frequency counts of D6 and D7 (pre and post goals related to technology and learning) STATS: frequencies, %

Note: I-Group = Intervention group; C-Group = comparison group

APPENDIX D

PARTICIPANTS' RESPONSES TO THE OPEN-ENDED SURVEY

OPEN-ENDED QUESTIONNAIRE

	Q1	Q2	Q3	Q4	Q5
	Would you recommend a colleague to become involved in next year's ITEL program (similar to what you experienced this year)? Briefly describe your reason for this answer.	**Please list 5 words (not phrases) that describe your experience in the yearlong ITEL professional development program you have just completed.**	**At this time, do you plan to develop a PBL unit for use in your classroom? Please explain your reason for this answer.**	**Briefly describe anyway in which the ITEL program may have impacted your teaching practice during this academic year.**	**Briefly describe any recommendations you might have for improving the ITEL professional development program for next year**
5	Yes, I learned about technology we currently have in my school and have better been able to make use of it this year.	challenging, collaborative, interesting, self-satisfying, fun	Yes, the $600 is a good incentive. I believe that my students will benefit in a PBL setting.	As I stated in #2 I have made more use of the technology currently purchased and available in my school.	
6	No, Though I found it to be very beneficial while reflecting at meetings end, it was not what I expected. It seemed as if all the "grunt work was saved for the last meeting and sessions were somewhat of a waste. If meaningful work was put to the ending project then yes I would recommend it.	cooperative, challenging insightful, enlightened, proficient	Yes, I am excited by the topic of the grizzly. At projects begin, I know nothing about there, but soon gained a lot of info on them. I am excited about choosing another focus.	Using the internet as a resource. Often times I relied only on printed info. In literature, but I am not comfortable enough to search the web for more info.	Make sure that group create or work on something to enhance their project (actual become a part) each meeting. I felt like the bulk of work cam one 1 month to completion.
7	Yes, I have enhanced my knowledge and functionality with tech. To the point that I feel comfortable teaching students with it.	invigorating, enhancing, imagination, freedom, self-learning	Yes, I like the freedom of learning choice/chains. To see the students who want to go the extra mile actually go is worth everything I do.	I have started giving my students more freedom on their own projects. They choose how & what they want to learn.	Keep the meetings off-campus as much as possible. Parking is a nightmare.
8	Yes, I believe that I have learned an abundance amount of info on technology that I didn't know before. This course was a helpful tool for my classroom.	confusion, helpful, team-based, improvement, relief	Yes, I believe that if I had a little more info on the PBL unit this would be an easy assignment, but I am definitely going to try to do it.	I was able to use the technology and adapt it to my lessons.	This was a hard class at first to understand what was wanted, maybe have a specific agenda.

9	No, I felt the program lacked some direction.	confusing, exciting, challenging, rewarding, undecided	Yes, I want to see if I can develop one to use next school year.	I have a much better understanding of the computer and its uses in the classroom.	It needs to be more focused. I felt there was a lot of good energy and ideas, but I felt we could of done more with the time we had.
10	Yes, New comfortability with technology use is valuable. Problem based learning lessons are a valuable strategy for teachers.	confusing, entertaining, discovery, growth, cooperation	Yes, In collaboration with an academic team member, a curriculum based PBL would be beneficial to student learning and personal growth.	Acquisition of a greater understanding of PBL style on its used by other academic team members. Greater trust in the value of academic time spent in cooperative groups.	Devote more class time to the group project (at least one more session would have been nice.)
11	Yes, Opportunity to grow teacher-knowledge of technology while applying new technology in the classroom to enhance student learning.	stimulating, supportive, tenacious, applying, investigating	Yes, My gains from this year-long study need to be exercised and built on.	I was able to assist fellow teachers and my students with technology use in the classroom, e.g. attachments, locating excellent web sites.	Assist students to identify technical skills they already have and will want to have by time to do final project in the beginning of the study.
13	Yes, I believe that you gain so much when given the opportunity to collaborate with your "peers". Teachers encourage this in their classrooms, but don't often practice it themselves. It is an opportunity to gain new "insights".	frustrating, rewarding, insightful, interesting, motivating, FUN	Yes, I believe that it can be a useful tool in the classroom.	My students viewed me as a "student" as well as their teacher. I forced myself to venture outside of my technology comfort zone.	I understand the need for PBL's to incorporate a "messy" problem, question or situation. But because of "life", (families, work, location, time, etc.) a little more organization or focus would be good.
14	No, I felt that the information presented was not worthwhile. I feel left out as far as a PBL unit. I do not have the knowledge to create one on my own.	confused, stressed, excited, challenged, shocked.	Unsure, I am not sure where I begin. Time/curriculum constraints.	There are a lot of resources, lot of interactive websites.	I think ITEL participants should be involved together in a PBL unit.

15	Yes, I don't feel I received what I needed to do a PBL unit in my classroom. I feel that the sessions were interesting but not enough to prepare me for the final project. I think that the way it was done last year gave participants a better idea of what to do. I think that sessions were not prepared in advance.	confusing, interesting, disjointed, alternative, ?	Yes, I do plan to develop a unit, but do not feel prepared to do so.	I don't feel that my teaching was impacted.	Have participants develop a PBL unit, not write lesson plans. I already knew how to do that. Be better prepared for class sessions. Actually teach them how to do things i.e. I have no clue how to create a web quest.
21	Yes, Although frustrating at this I do believe this course to be beneficial to teaching effectiveness. Great new ideas and skills!	frustration, confusion, anxiety, accomplishment pride.	Yes, As stated before I believe the techniques and strategies involved w/ PBL's facilitate better learning on the part of the student. Retention is higher!	Students are preprogrammed today to respond positively to technology, and consequently are more likely to be actively engaged in the learning process when accompanied by technology!	1. Changing times, dates of meetings at last minute should be kept to a minimum. 2. Perhaps more college credit available.
22	Yes, I believe that this was a valuable experience for me. I enjoyed working with colleagues I wouldn't normally work with due to content differences. I was introduced to new ways to incorporate student focused learning in my classroom. I can directly see how this would be applied in my classroom that would benefit all involved.	informative, challenging, entertaining, captivating, and determination.	Yes, I teach an applied science course in which the text book is already set up as an "issue" based book. Some of the units scenarios are weak and poorly developed and this course has shown me a way that they could be enhanced or easily altered to better suit the students and learning.	It has opened my eyes to new software and web capabilities that I didn't know how to do before. I have seen things I would like to incorporate into my class time and power point (slides?) that would spice things up a bit.	I believe more time with your groups to discuss and plan at the meetings instead of leaving that to out of class time. It is better to work while ideas are fresh and we are focused on issue at hand. As soon as we leave, other responsibilities take us away from developing useful ideas for immediate use. The longer you wait to apply the less likely I am to implement.
23	Yes, I generally recommend NEW experiences from a philosophical base. Also, I think the ITEL program has a pretty good "range" in terms of amount of time necessary - e.g. participants can control that.	frustrating, challenging, provoking, tiring, satisfying	Yes, the unit I developed for this ITEL class is (mostly!) "ready to go" for use in my classroom. I probably will not do another unit.	Some positive impact on my willingness to assign a project and let it develop a life of its own w/out my "micro management."	First, I'd characterize this year w/ "strong opening, weak "middle", strong closing. Perhaps it was just me, but I felt we lacked direction in the middle months.
24	No, I will only use filamentality in the future from this course, webquests, hunts, etc. This could have been acquired by inservice on that web tool.	confusing, unclear, organized open-ended, exciting	Unsure, time factor. Still unsure of what is required.	Not at all	Do not have individual groups work towards a big question posed and then groups support. I believe that the format was difficult.

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