Teaching Instructional Technology: A Problem-Based-Learning Approach

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Abstract: Problem-based learning (PBL) is an instructional model which uses authentic, real life problems to create an active, student-centered learning environment and which promotes the development of critical thinking skills. While PBL strategies have been implemented in numerous disciplines, there are few examples of PBL being used in undergraduate teacher preparation. The purpose of this study was to design and implement an undergraduate instructional technology course grounded in PBL principles. Course designers implemented a PBL-based course that included six phases: problem formulation, data collection, brainstorming solutions, evaluation and selecting solutions, implementing the solution, and assessment. Using this approach, students examined problems teachers may have integrating technology into instructional and/or professional activities, developed strategies to eliminate this problem, and designed, developed, and implemented their chosen strategies.

Resume: L'apprentissage par probleme (APP) est un modele qui utilise des veritables problemes tires du vecu afin de creer un environnement actif, centre sur 1'apprenant et qui favorise le developpement des habiletes de la pensee critique. En depit du fait que les strategies de 1'APP ont ete implantees dans plusieurs disciplines, il exisite pen d'exemple de 1'exploitation de I'APP en formation initiale des enseignants. L'objectif de cette etude etait de creer et d'implanter un cours en technologic educative fonde sur les principes de I'APP. Les concepteurs du cours ont implante un cours base sur I'APP incluant six etapes: 1'enonce du probleme, la collecte des donnees, le remu meninges au sujet des solutions, revaluation et le choix des solutions, I'implantation des solutions et 1'evaluation. En utilisant cette approche, les etudiants ont examine les problemes que des enseignants peuvent avoir en tentant d'integrer les technologies en classe ou dans des activites professionnelles, ils ont developpe des strategies pour eliminer ces problemes et ils ont con£u, developpe et implante leurs propres strategies.

introduction

In recent decades, teachers, instructional designers, and other educators have increasingly been urged to adopt philosophies that embrace and support student-centered learning environments (Means, 1995). A particular emphasis of this movement has involved shifting the focus of classroom teaching and learning from the teacher and/or the subject matter to the learner, inviting students to take a more active role in their learning.

Advances in cognitive psychology and related fields have provided important information regarding the desirable types of student actions and interactions within the

Canadian Journal of tducational Communication, Vol. 27. No. 1, Pages 1-18, iSSN-0710-4340

learning context to maximize knowledge acquisition and construction. For example, a theory of situated cognition suggests that knowledge is situated in the activity, context, and culture of which it is a part (Brown, Collins, & Duguid, 1989). In this view, learning is a process of enculturation. To become expert at using the tools of a particular domain, learners must adopt and become part of the culture in which those tools are to be used (Lave & Wenger, 1991).

Anderson and Armbruster (1990) listed a number of "maxims" about teaching and learning that are grounded in cognitive theories and reflect a constructivist philosophy of instruction. That list includes:

- *Instruction should use a whole-to-part approach.* Students must have a sense of the whole task before learning subskills or component parts of a task. Learning of these subskills should take place in the context of the whole.
- *Instruction should be rooted in authentic, real-world situations.* Instruction not in authentic situations often leads to oversimplifications making knowledge rigid and less functional.
- *Instruction should foster flexibility through multiple perspectives.* Students must be able to tackle complex problems from multiple perspectives and with a number of strategies that can be flexibly applied.
- *Instruction should assume an action orientation.* Students must be actively involved in their own learning. Learning and doing work simultaneously. Novices must work in the same authentic environments as experts in order to develop procedural know ledge and link it to conceptual knowledge.

Various instructional and curricular strategies that reflect a belief in the previous statements have been developed and implemented in some fashion. One such approach that embraces many of the ideals of constructivism is problem-based learning (PBL) (Barrows & Tamblyn, 1980; Savery & Duffy, 1995). This model uses authentic, real life problems to create an active, student-centered learning environment. "Problem-based learning is the learning that results from the process of working toward the understanding or resolution of a problem. The problem is encountered first in the learning process" (Barrows & Tamblyn, 1980, p. 2). PBL contrasts with more traditional instructional approaches in which content is usually presented first and then a related problem is presented as an example or assigned as an exercise. Despite the intuitive appeal of PBL, teacher educators have been slow to adopt these strategies and few examples of implementation in this area exist in the literature. Our purpose in this article is to outline a theoretical basis for PBL and to describe initial efforts to implement PBL in an undergraduate instructional technology course for preservice educators.

Problem-Based Learning

Problem-based learning has its roots in medical education, primarily due to the efforts of Howard Barrows (Barrows. 1985; Barrows & Tamblyn, 1980). Over the past few decades, PEL has been successfully implemented in other health care fields such as optometry (Whirtaker & Scheiman, 1996), dentistry (Branda, 1990) and pharmacy (Duncan-Hewitt, 1996). Other educators have been slower to adopt PBL as an instructional method; however, reports of PBL use have increased in higher education and more traditional K-12 subjects such as social studies (Gallagher, & Stepien, 1996), mathematics (Alper, Fendel, Fraser, & Resek, 1996), science (Gallagher, S., Stepien, W. J., & Workman, D., 1995), gifted education (Gallagher, & Stepien, 1996), geography (Bradbeer, J., 1996) and educational administration (Bridges & Hallinger, 1995; Cordeiro & Campbell, 1995; and Tanner, Keedy, & Galis, 1995).

According to Bridges and Hallinger (1992) problem-based learning has five essential characteristics:

- The starting point for learning is a problem.
- The problem is one students are apt to face as future professionals.
- The knowledge that students are expected to acquire during their professional training is organized around problems rather than disciplines.
- Students, individually and collectively, assume a major responsibility for their own instruction and learning.
- Most of the learning occurs within the context of small groups rather than lectures (p. 6).

"PBL problems may be presented in various ways - written cases, vignettes with limited information (additional information supplied in response to students' requests for specific data), filmed episodes, and real-time problematic situations" (Bridges & Hallinger, 1995, p. 14). Problems can be viewed as *anchors* (Cognition and Technology Group at Vanderbilt, 1993) for the learning activity. Effective anchors must "capture the imagination, be perceived as important by learners, legitimize the disciplinary content they integrate, and accommodate a variety of learning approaches" (Barab & Landa, 1997, p. 53). PBL anchors, or problems, must be specific enough that students and teacher understand and agree upon the topic and must be general enough to be pursued from multiple perspectives based on individuals' prior experiences and knowledge about the subject. Problems that are ill-structured are particularly well-suited for the PBL approach (Jonassen, 1997; Koschmann, Kelson, Feltovich, & Barrows, 1996).

Structure of Problem-Based Projects

Two common types of PBL are problem stimulated and student centered (Waterman, Akmajian, & Kearny, 1991). The type depends on who defines the specifics of the problem-based activity. Ross' general taxonomy for PBL (1991) depicts the various ways problem-based projects can be carried out in the classroom depending on the purposes of the instruction:

- Problems can be selected by the curriculum design team (or individual) without assistance, by the curriculum design team from problems listed by students, or by students as a group or as individuals.
- The problem can be selected to ensure that students cover a predefined area of knowledge, to help students learn a set of important ideas and techniques, for its suitability for leading students to the "field," for its intrinsic interest or importance, or because it represents a typical problem faced by the profession.
- The form that the problem takes could be an event (or "trigger"), a descriptive statement, or a set of questions.
- The resources students will use can be selected by the design team, the students from a resource package accumulated by the design team, or the students from any sources available to them.
- Students can work in groups with a tutor, in groups without a tutor, or as individuals (Tanner, Keedy, & Galis, 1995, p. 155).

Although there are numerous ways that a problem-based unit could be enacted, projects typically follow the six phases outlined by Seifert & Simmons (1997).

Problem Formulation. During the initial phase, students work with their teacher to determine what is already known about the problem, to determine what additional information needs to be learned to help solve the problem, and to identify strategies to facilitate the problem-solving process.

Data Collection. Collecting data related to the problem occurs in the second phase. Before allowing his/her students to begin this activity, the instructor may find it useful to review various data collection methods. It may also be necessary for the teacher to demonstrate, discuss, and teach students to interpret statistics. Students should be encouraged to search for data in places they would not normally search, to view the problem from many perspectives, and to listen carefully and be open to new ideas.

Brainstorming Solutions. After collecting various pieces of information related to the problem, students and, to some extent the teacher, should begin to brainstorm possible solutions. The teacher, or a student volunteer, should write the ideas on the chalkboard for everyone to read. During this session, emphasis is on the range of possibilities, not the correctness of an idea. The teacher, or other group facilitator, should take time with this process so all students have opportunities to completely express their ideas. Students should be encouraged to immerse themselves in the problem; to review as many things as possible about the ideas; to rearrange the order of the parts; to keep a list of ideas, regardless of their probability; and to share ideas.

Evaluating and Selecting Solutions. As the list of possible solutions is pared, students should assess each solution against the collected data. Positive and negative aspects of each solution should be explored. The group should discuss each solution listed until consensus can be reached on one solution.

Implementing the Solution. While actual implementation of the chosen solution would be ideal, in many PBL projects it may not be practical to do so. For example, law students studying a problem related to a legal case would be unable to see their solution tested in judicial proceedings. At a minimum, however, students should describe their plan for implementation, creating realistic supporting documents when appropriate. Students should be able to support their choice using the data they collected in a presentation to the class as well as in a formal, written paper to be submitted to the instructor.

Assessment. The final phase consists of determining the methods and standards by which student work will be assessed. Any of the following assessment practices, or more likely a combination of them, may be useful in assessing PBL projects. Students may be given general guidelines to use in developing their own assessment tools for their group's project. The teacher who also evaluates the final written document may wish to average the teacher- and student-derived grades for an overall grade for the project. Additionally, teacher and/or peer evaluations may be useful in assessing the quality of group work.

Bridges and Hallinger (1995) provided additional techniques for students' self-assessment of their products, such as integrative essays in which students discuss what they learned during the project and how they might apply that knowledge in the future, comparison to established protocols (e.g., checklists or guidelines), comparison to expert-completed products, completion of knowledge review exercises which test students' abilities to apply the information they have learned, and critical assessment of the product in light of key questions about the problem issue.

Effects of PBL

Some parents and perhaps some educators may question whether students acquire sufficient amounts of content using a PBL approach (Gallagher & Stepien, 1996). While students may be engaged in deeper levels of content related to their specific problem, it could be argued that they may not receive the breadth of content that more traditional methods support. However, there is growing support that PBL is as effective as traditional methods in terms of factual recall. Barab and Landa (1997) reported that students learning content in the process of solving some problem scored higher on achievement questions and evidenced more transfer of knowledge than did students who studied the information without the problem as an anchor. Gallagher and Stepien (1996) reported similar findings as students in a problem-based course scored similarly to students in traditional classes and actually had the highest average gain of any of the groups under study. Alper, Fendel, Fraser, and Resek (1996) cited several studies that showed students participating in mathematics classes which used the PBL approach scored as well as other students on standardized tests such as the SAT.

Problem-based learning has also shown positive results in students' affective domain. Tanner, Keedy, and Galis (1995) reported receiving student evaluations that were much more positive than those received in years prior to implementation of PBL. In an innovative high school mathematics program which utilized the PEL approach, students were found to enroll in math classes beyond those required more often than students in classes featuring more traditional methods (Alper, Fendel, Fraser, & Resek, 1996).

Problem-based learning has been presented here as a student-centered model for teaching and learning which takes advantage of the inherent qualities of searching for solutions to authentic problems. As educators continue to emphasize the importance of developing critical thinking and problem solving skills, they should find PBL a viable model for advancing these desired goals. Savery and Duffy (1995) summarize PBL as a prototype model for instituting these core constructivist principles of learning:

- Anchoring all learning activities to a larger task or problem.
- Supporting the learner in developing ownership for the overall problem or task.
- Designing an authentic task.
- Designing the task and the learning environment to reflect the complexity of the environment they should be able to function in at the end of learning.
- Giving the learner ownership of the process used to develop a solution.
- Designing the learning environment to support and challenge the learner's thinking.
- Encouraging testing ideas against alternative views and alternative contexts.
- Providing opportunity for and supporting reflection on both the content learned and the learning process (pp. 32-34).

Integrating PBL in Undergraduate Teacher Education

While PBL strategies have been implemented in numerous disciplines, there are few examples of PBL being used in undergraduate teacher preparation. This is disappointing since much of a teacher's success in the classroom is based upon how well they can identify, analyze, and solve problems presented to them. These problems may be based on curriculum issues, student behavior, administrative duties, or professional interactions with their peers. For example, teachers are asked virtually every day to deal with student learning and behavior issues in their classes. The expectations are that they will be able to analyze their curricular goals and objectives and develop instructional strategies to facilitate student success in meeting these goals. If some students are having difficulty meeting the goals via the strategy the teacher has devised, the teacher is expected to revise or modify the strategy in order to help all students succeed.

Similarly, teachers are routinely provided with new tools and strategies that they are expected to integrate into their instructional activities and yet are provided with little (if any) additional training or development time to assist with the implementation of these new procedures or tools. A classic example of this is instructional technology. Schools across the United States are spending millions of dollars upgrading their instructional technology facilities and equipment, yet teachers feel ill-equipped to handle this influx of new materials and the expectations that come along with this large investment. Although technology is becoming more and more prevalent in schools (Ely (1995) has noted that the student/computer ratio in U.S. schools has dropped from 1/75 in 1984 to under 1/12 today), research continues to show that teachers feel ill-prepared to effectively use technology in their classrooms (Bosch & Cardinale, 1993; Office of Technology Assessment, 1995; Topp, Mortensen, & Grandgenert, 1995). Because teachers still feel uncomfortable truly integrating technology into their instructional activities, they continue to use computers for low-level, supplemental tasks such as drill and practice activities, word processing, educational games, and computer-based tutorials (Ely, 1995; Hunt & Bohlin, 1995; Office of Technology Assessment, 1995). Some researchers have even gone so far as to state that "...few teachers routinely use computer-based technologies for instructional purposes" (Abdal-Haqq, 1995, p. 1).

In an attempt to address the criticisms discussed in the research and to provide students with a PBE experience, we decided to focus on revising a course specifically designed to provide prospective teachers with instructional technology skills and experiences. The course, EM370 - Computer Applications in Education, is offered three times a year by the College of Education, and is the only four-hour course dealing with uses of technology in educational settings available to pre-service teacher education students. The six students who took this elective course were all seniors who had already taken the required undergraduate educational technology course, a two-hour course designed to provide students with basic computer skills such as file management, word processing, spreadsheets, presentation graphics, and Internet. The three female students were elementary education majors, two of the male students were secondary education majors, while the third male was a health and human performance major (an education, but non-teaching, major). Half of the students had completed methods courses in their programs.

Prior to its redesign, EM370 focused on teaching basic technology skills with an emphasis on using these skills for classroom management purposes. Objectives for the course centered around six technology skill areas: basic technology concepts, personal/professional use of technology, application of technology in instruction, using technology for productivity, using technology for teaching, and using technology for organization/administration (see Brush (in press) for a more detailed description of the EM370 class). While these core objectives did not change for the redesigned course, the skills and concepts covered in this class were driven by the need to solve a real-world educational problem, rather than by a teacher-selected predetermined sequence of instruction.

In order to achieve this goal, we used Seifert and Simmons' (1997) six-phase model for creating a PBL environment (problem formulation, data collection, brainstorming solutions, evaluating and selecting solutions, implementing a solution, and assessment) as a guide for designing class discussions, exercises, and assessment activities. Below is a description of the structure of the class, along with examples of student activities and samples of student materials.

Phase 1 - Problem Formulation

In order to devise an ill-structured problem suitable for this content, we consulted with various individuals including other teacher education faculty, classroom teachers with various levels of experience, school administrators, and university students. Based on these discussions, we devised the following problem as a basis for the class:

Setting. You are a new teacher at a K-12 school in Alabama. You are excited about your new job, partly because the school has spent over $3 million on technology enhancements for the district. Each building in the district is now equipped with both local-area and wide-area networking, a video system with access to cable TV and satellite programming, portable laserdisc players, two 30-station instructional computer labs, and a large assortment of instructional software. Each classroom has three computers with CD-ROM capabilities. Each computer already has ClarisWorks, HyperStudio, and Netscape Navigator preloaded. In addition, each classroom has a teacher workstation with additional administrative software (electronic gradebook, lesson plan designer, test generation software).

The Problem. No one is using the technology! Teachers aren't integrating technology into classroom activities, students are using computers for low-level tasks such as word processing and remedial activities, and building administrators aren't overly concerned that the technology isn't being used. However, the superintendent is getting lots of pressure from the school board to figure out why the district spent $3 million on hi-tech paperweights! She decides to hire an educational technology consultant named Dr. Tom Brush to determine what needs to be done to get teachers and students using the technology effectively.

The Challenge. Dr. Brush has asked you (meaning everyone taking EM370) to help him solve this problem and act as "early adopters" for whatever strategies are developed. He has requested that you assist him with the following activities:

(1) determine reasons why teachers are having difficulty integrating technology into instructional and/or professional activities;

(2) develop strategies for eliminating the problems identified in (1), and;

(3) design, develop, and implement the strategies outlined in (2).

This problem was a realistic one that these students could conceivably face in the future (Anderson & Armbruster, 1990; Bridges & Hallinger, 1992; Savery & Duffy, 1995) and it was broad enough to be approached from multiple perspectives (Barab &Landa, 1997).

Phase 2 - Data Collection

After discussing the problem statement with the "solution team" and clarifying any confusion regarding team member roles, responsibilities, and requirements, the team engaged in a brainstorming session in order to determine the types of data and data sources we would need in order to begin formulating potential solutions to the problem. This discussion led to the formulation of a data "wish list," which was pared down by the team and categorized into the following areas:

Interviews
- Teachers
- Administrators
- Parents
- Board Members
- Community Leaders
- Educational Technology Experts

Observations
- Teachers
- Administrators
- Students

Materials
- Research/Professional Literature
- Curriculum Guides
- Training Schedules and Materials
- Technology Planning Documents
- District Strategic Plan
- Teacher/Administrator Evaluation Procedures and Policies

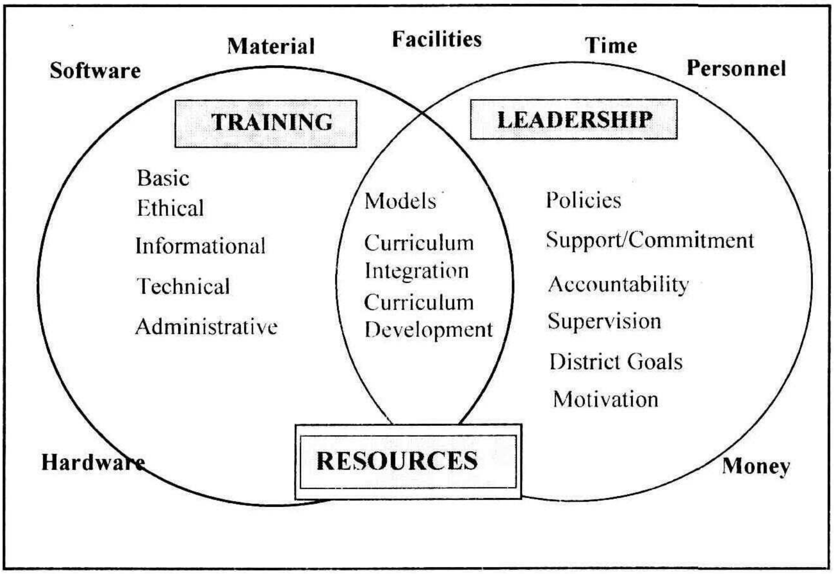
The team then delegated responsibilities for acquiring the information to individual members. Through this process, the team was able to interview several teachers, administrators, and parents from a local school, conduct site visits of schools in the area, and acquire curriculum information, technology plans, school strategic plans, and other documentation from both local and electronic sources. All of this information was maintained in a "problem resources" file available to all team members.

Once the data was collected, team members were asked to analyze and synthesize the data into "Barriers to Technology" essays in which they outlined the reasons why technology was not effectively utilized in their school. These essays served as an impetus for the team developing a "Technology Barriers Model," which in turn served as a framework for brainstorming potential solutions to the problem (see Figure 1).

Figure 1. Barriers to technology integration.

BARRIERS TO TECHNOLOGY INTEGRATION

EM370



Phase 3 - Brainstorming Solutions

Having collected data from various sources and formulated some initial hypotheses related to the problem, the team discussed their views of the data and brainstormed potential solutions to the barriers and issues they identified. The brainstorming sessions resulted in a list of potential solutions to one or more of the issues identified in the data collection phase (see Table 1).

Phase 4 ~ Evaluating and Selecting Solutions

After generating a list of possible solutions, team member were asked to individually evaluate the potential solutions and formulate a position essay in which they selected a solution strategy, outlined and defended their rationale for selecting the solution, and explained the methodology for implementing the solution. The other team members, as well as the teachers, parents, and administrators interviewed in the data collection phase, evaluated each of the team members' essays. From this feedback the team selected three solution ideas which had the most positive evaluations. The solution ideas selected for further development included:

(1) Develop and implement an ongoing training and support strategy;

(2) Develop a database of teaching and learning resources, along with examples of how these resources could be integrated into various classroom activities/content areas;

(3) Develop policies and guides for teachers and administrators including accountability standards, future goals, motivational strategies, and policy statements.

Table 1. Solution Brainstorming Results.

Solutions to Technology Integration Barriers

EM370 - Spring 1997

Training	**Leadership**	**Resources**
Implement "train the trainer" program	Job descriptions for technology staff	Specific technology leader and leadership staff
Release time for conferences	Provide school/ community recognition for innovative teachers	Models of student-centered technology activities
Planning time and training days	Develop expectations for teacher/student use of technology (and hold individuals accountable)	Develop technology curriculum
2-day release time for training	Set higher standards in teacher ed. programs	Hire "technology integration" support personnel
Topical workshops (teachers choose)	Principals report technology use at district meetings and board meetings	Gather research on successes/failures of other schools
Workshops for prc-service teachers	Establish "policies" committee	Establish "networking" structure and strategies between teachers
Ongoing and flexible training schedule	Establish inter-curricular and inter-school technology competitions	Provide home access to district network
Establish baseline teacher competencies	Establish "technology teams" at each school	Develop computer check-out program
	"Show and tell" at board meetings and administrator observations	Administer needs assessment of student/ teacher use of technology
	Establish school/ community and school/ business partnerships	Identify building-level student and teacher technology advocates
	Develop grade-level technology benchmarks	Maintain journal/records of student and teacher technology use
	Encourage community involvement for resource selection and acquisition	Develop technology newsletter
	Establish district technology goals	Develop "integration ideas" database
	Develop accountability procedures and incentives for all staff	Funds for continuing/ graduate education
		Rewards for conference presentations
		Technology staff (or department)
		"Guidelines" book including integration tips
		Software/materials inventory
		Promotional video

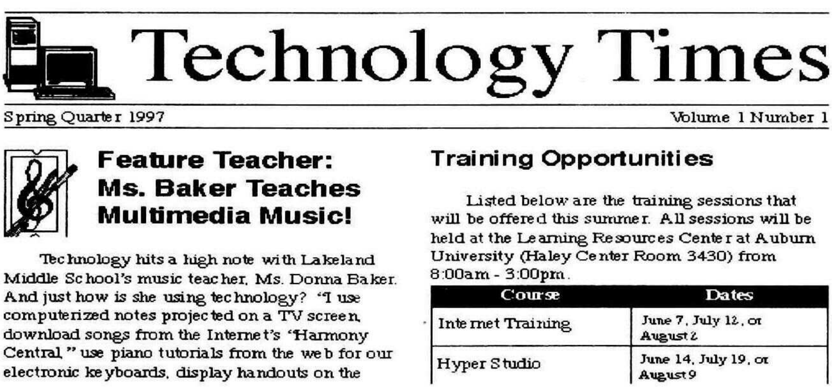
Phase 5 - Implementing Solutions

The solution team then formed new groups based on the solution they were most interested in pursuing. Once team members finished forming their sub-groups, they were asked to provide an outline of their strategy for developing and implementing the solution they selected. These outlines provided the groups with an activity whereby they could reach consensus on what they needed to develop and to delegate responsibilities among sub-group members. The sub-groups spent the next four weeks completing their solution projects. Based on the specific needs of each sub-group, we provided students with assistance, both individually and in small groups, in developing the necessary technical skills to complete their tasks. For example, two students from different sub-groups identified a need to learn to use desktop publishing software. We provided these students with self-paced tutorials as well as individual training sessions to assist them in their efforts. Students discovered that they not only needed to learn how to use the desktop publishing software, but that they also required some skill in laying out a newsletter in an appealing design.

Figure 2 displays the work of one sub-group which used a popular desktop publishing application to design a school technology newsletter. The newsletter included information designed to motivate and assist teachers to integrate technology into their daily activities. For example, the four-page newsletter included a "Feature Teacher" section to spotlight how a teacher uses technology in her classroom, a technology training schedule, a list of instructional resources on the web, a software review, and tips for the one-computer classroom. Many of the ideas included in the newsletter were a direct result of discussions with teachers in local schools. While not a complete solution, the newsletter included components of each of the three idea solutions identified by the team. For example, the newsletter itself was viewed as part of an ongoing support strategy.

The final activity for the sub-groups was to present their solutions (along with supporting materials they developed) to an evaluation group of teachers, parents, faculty, and other students. The evaluation group critiqued the solutions and materials and provided the solution teams with additional ideas for improving their products.

Figure 2. Example of technology newsletter created with desktop publishing software.



Technology Times

Spring Quarter 1997 — Volume 1 Number 1

Feature Teacher: Ms. Baker Teaches Multimedia Music!

Technology hits a high note with Lakeland Middle School's music teacher, Ms. Donna Baker. And just how is she using technology? "I use computerized notes projected on a TV screen, download songs from the Internet's "Harmony Central," use piano tutorials from the web for our electronic keyboards, display handouts on the

Training Opportunities

Listed below are the training sessions that will be offered this summer. All sessions will be held at the Learning Resources Center at Auburn University (Haley Center Room 3430) from 8:00am - 3:00pm.

Course	Dates
Internet Training	June 7, July 12, or August 2
Hyper Studio	June 14, July 19, or August 9

Phase 6-StudentAssessment

In order to assess student knowledge and competence, evaluation rubrics were devised specifically for this class. For example, the rubric displayed in Figure 3 was used to evaluate student solutions to the problem, their major project. Students were evaluated on their project proposal and the instructional content, instructional design, and presentation of their final product. The overall evaluation plan for the course included assessment of both individual and group activities and allowed for peer and professional evaluations of group projects.

From an individual standpoint, 50% of the class grade was based upon the two student essays (barriers to technology and potential solution) and a take-home exam in which students were required to provide strategies and solutions to potential technology-related problems they may encounter in their future professional placements (see Figure 4 for examples of final exam questions). From a group standpoint, 30% of students' grades was based upon successful completion and presentation of their "solution" projects, while 20% of their grades was based upon peer and "outside" professional evaluations of their performance and participation. The multiple evaluation methods (Bridges & Hallinger, 1995; Seifert & Simmons, 1997), including peer and instructor assessments, provided a richer picture of the quality of the students' work.

Figure 4. Sample final exam questions.

1. Please discuss *what you believe* is the single most important barrier to overcome in order for technology to be better accepted and utilized in education (other than funding). Support your response with class readings, class discussions, and teacher and parent interviews.
2. Please discuss *what you believe* is the single greatest benefit of integrating and using technology in education. Support your response with class readings, class discussions, and teacher and parent interviews.
3. You are a teacher at a school that has just purchased new computers for every classroom. You are sitting in the teacher's lounge one day when a colleague comes in looking frustrated. "I just can't get the hang of these new machines," he says. "I've been teaching for 20 years and my students have done just fine without computers. Why is it so important for me to use a computer in my classroom now?" Describe how you might persuade this teacher that the computer is an important and useful tool in his class.
4. You are a new teacher at a school in rural Alabama fortunate enough to have access to the Internet in every classroom. A parent of one of your students comes into your room one day after school. He is upset that you are requiring his child to complete a class research project using information gathered off the Internet. He claims that the Internet is "just a collection of pornography and leftist propaganda." What strategies would you use to persuade this parent that the Internet is an important educational tool?

Figure 3. Assessment rubric for student problem solution.

Summary

The purpose of this paper was to provide a theoretical rationale for problem-based learning strategies and to discuss our attempts to implement a PBL environment in a pre-service teacher education course. This implementation of PBL closely followed the six phases outlined by Seifert and Simmons (1997): problem formulation, data collection, brainstorming solutions, evaluating and selecting solutions, implementing a solution, and assessment. Additionally, the five characteristics Bridges and Hallinger (1992) claim are essential for PBL environments were clearly visible in this course. First, the starting point for learning throughout the course centered on the stated problem. Second, the problem was realistic and perhaps similar to one that these students may face in their professional endeavors. Third, the knowledge and skills learned in this class were organized around the stated problem and related sub-problems, rather than by the instructional technology discipline. Fourth, students took responsibility for their own learning, both in group and individual settings. Finally, the majority of student learning occurred in small group settings.

While all students in the course may not have achieved all of the technical skill objectives, they did immerse themselves in learning a smaller subset of those objectives and, more importantly, learned about underlying processes that influence, and are impacted by, instructional technology—an essential component of learning according to Anderson and Armbruster (1990). Through their participation in the PBL course, students were exposed to a wide variety of potential barriers they may face when trying to implement any new tool or strategy into education, as well as strategies they may be able to use to break down those barriers. Through their research and development efforts in this class, students acquired an array of technology skills and experiences within the context of developing their solutions. These skills ranged from learning to use productivity software such as desktop publishing, spreadsheets, databases, presentation, and multimedia packages, to utilizing online resources such as electronic mail and the world-wide-web for communication and information retrieval, to acquiring a deeper understanding of curriculum resources and planning, instructional materials evaluation, and instructional design. At the very least, students had access to and interacted with a vast amount of technology-based instructional materials and learned to utilize appropriate materials to enhance their classroom instruction. While previous EM370 students also learned a variety of technology skills, their experiences were seldom explicitly linked to real educational problems.

From their experiences in EM370, students learned that educational technology is not a concept referring to classroom management tools and administrative applications, but that the technology resources available to teachers today can truly revolutionize the way we teach as long as they address and overcome the barriers to integration. With this knowledge, it is hoped that these students will act as technology leaders and change agents in their future professional placements.

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