CANADIAN JOURNAL OF EDUCATIONAL COMMUNICATION

Volume 27, Number 1, Spring 1998
ISSN 0710-4340

An AMTEC Publication

Canadian Journal of Educational Communication

Volume 27, Number 1
Spring 1998

Editor
David A. Mappin

Guest Editor
Richard F. Kenny

Book Review Editor
Diane P. Janes

Media-wars Review Editor
Len F. Proctor

Translation
Francois Desjardins

Production Manager
Pat Mannion
Patrician Desktop Publishing

The Canadian Journal of Educational Communication is published by the Association for Media and Technology in Education in Canada: 3-1750, The Queensway, Suite 1318, Etobicoke, Ontario, M9C 5H5, Attention: Director of Membership. Subscription inquiries and notification of address changes should be sent to the above.

Back issues ofCJEC are $16.05 Canadian and may be obtained by contacting the Editor. CJEC is indexed in the Canadian Education Index and ERIC.
This journal is published with the assistance of a grant from the Social Sciences and Humanities Research Council of Canada.

Articles

Special Issue on Technology and Teaching

Ail correspondence should be addressed to:
David Mappin
Division of Technology in Education
3-102 Education North
University of Alberta
Edmonton. Alberta T6G 2G5
E-Mail: DavidMappin@Ualberta.ca

CJEC is typeset in Microsoft Word 97.
Printed by: Quebecor Jasper Printing Inc.
Edmonton, Alberta

1998 – 1999 Subscription/ Membership Form

AMTEC c/o Brian Smalridge
3-1750 The Queensway, Suite 1818
Etobicoke, Ontario, Canada M9C 5H5

Name: ____________________ Title: ____________________

Address: ____

Prov: ________________ Postal Code ______

Phone(w) ________________________ Phone (h) ______________

Fax ____________________________ Email ______________

☐ I am willing to have pertinent information from the above included in the next Members Handbook

ALL RENEWALS COME DUE ON EITHER JANUARY 1ST OR JUNE 1ST

If this is a renewal then please indicate your Membership Number

☐ Student of Education Technology (includes GST) -------------------- $53.50

☐ Retiree (includes GST) -- $53.50

☐ Individual (includes GST) -- $101.65

☐ Commercial (includes GST)--- $101.65

☐ CJEC Subscription Only - Canada (includes GST)-------------------- $80.25

☐ CJEC Subscription Only - U.S.A. ----------------------------------- US $75.00

☐ CJEC Subscription - Outside North America ---------------------- US $95.00

*Students must have this form signed by your Department Head

GST # 122939853

Teaching Instructional Technology: A Problem-Based-Learning Approach

Barry N. Scott
Thomas A. Brush

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 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

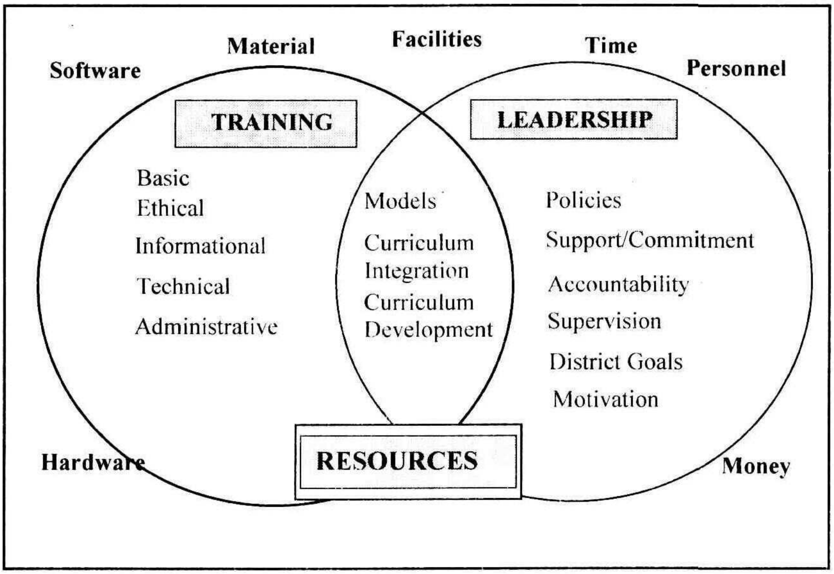
The team then delegated responsibilities for acquiring the information to individual members. Through this process, the team was able to interview several teachers, administrators, and parents from a local school, conduct site visits of schools in the area, and acquire curriculum information, technology 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

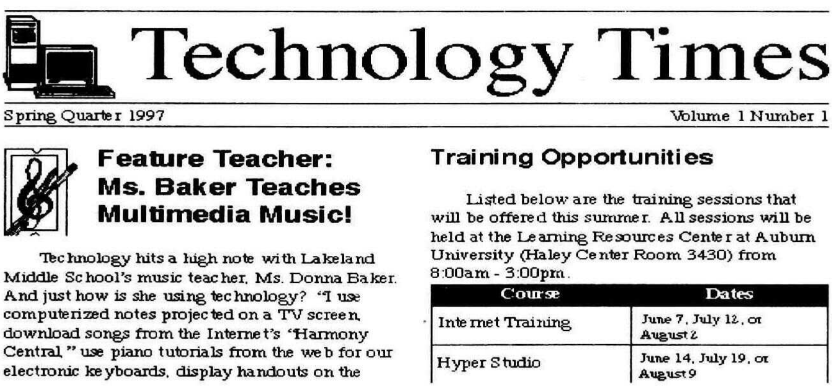
Phase 5 - Implementing Solutions

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.

References

Abdal-Haqq, I. (1995). *Infusing technology- intopreservice teacher education. ERIC digest.* (ERIC Document Reproduction Service No. ED 389 699)

Alper, L., Fendel, D., Fraser, S.. & Resek, D. (1996). Problem-based mathematics: Not just for the college-bound. *Educational Leadership,* 53(8), 18-21.

Anderson, R. C., & Armbruster, B. B. (1990). Some maxims for learning and instruction. (Report No. 491). Champaign, IL: Center for the Study of Reading. (ERIC Document Reproduction Service No. ED 314 741)

Barab, S., & Landa, A. (1997). Designing effective interdisciplinary anchors. *Educational Leadership, 54(6* 52-55.

Barrows, H. S. (1985). How to design a problem-based curriculum for the preclinical years. New York: Springer.

Barrows, H. S., & Tamblyn, R. M. (1980). Problem-based learning: An approach to medical education. New York: Springer.

Bosch, K. A., & Cardinale, L. (1993). Preservice teachers' perceptions of computer use during a field experience. *Journal of Computing in Teacher Education,* 70(1), 23-27.

Bradbeer, J. (1996). Problem-based learning and fieldwork: A better method of preparation. *Journal of Geography in Higher Education, 20(* 1), 11-18

Branda, L. A. (1990). Implementing problem-based learning. *Journal Of Dental Education, 54(9),* 548-549.

Bridges, E. M., & Hallinger, P. (1992). *Problem-based learning for administrators.* Eugene, OR: ERIC Clearinghouse on Educational Management.

Bridges, E. M., & Hallinger, P. (1995). *Implementing problem based learning in leadership development.* Eugene, OR: ERIC Clearinghouse on Educational Management.

Brown, J. S., Collins, A., & Duguid. P. (1989). Situated cognition and the culture of learning. *Educational Researcher, I8(\),* 32-41.

Brush, T. A. (in press). Teaching pre-service teachers to use technology in the classroom. *Journal of Technology and Teacher Education.*

Cognition and Technology Group at Vanderbilt (1993). Anchored instruction and situated cognition revisited. *Educational Technology, 33(3),* 52-70.

Cordeiro, P. A., & Campbell, B.(1995/ *Problem-based learning as cognitive apprenticeship in educational administration.* (ERIC Document Reproduction Service No. ED 386 800)

Duncan-Hewitt. W. C. (1996). A focus on process improves problem-based learning outcomes in large classes. *American Journal Of Pharmaceutical Education, 60(4),* 408-416.

Ely, D. P. (1995). *Technology is the answer! But what was the question?* (ERIC Document Reproduction Service No. ED 381 152)

Gallagher, S. A., & Stepien, W. J. (1996). Content acquisition in problem-based learning: Depth versus breadth in American Studies. *Journal For The Education Of The Gifted,* 79(3), 257-275.

Gallagher, S., Stepien, W. J., & Workman, D. (1995). Implementing problem-based learning in science classrooms. *School Science And Mathematics,* 95(3), 136-146.

Glasgow, N. A. (1997J. *New curriculum for new times: a guide to student-centered, problem-based learning.* Thousand Oaks, CA: Corwin Press.

Hunt, N. P., & Bohlin, R. M. (1995). Events and practices that promote positive attitudes and emotions in computing courses. *Journal of Computing in Teacher Education, 11(3),* 21-23.

Jonassen, D. H. (1997). Instructional design models for well-structured and ill-structured problem-solving learning outcomes. *Educational Technology Research & Development, 45(*\\ 65-94.

Jones, B. F., Rasmussen, C. M., & Moffitt, M. C. (Eds.). (1997/ *Real-life problem solving: A collaborative approach to interdisciplinary learning.* Washington, D.C.: American Psychological Association.

Koschmann, T. K., Kelson, A. C., Feltovich, P. J., & Barrows, H. S. (1996). Computer-supported problem-based learning: A principled approach to the use of computers in collaborative learning. In T. Koschmann (Ed.), *CSCL: Theory and practice (pp.* 83-124). Mahwah, N.J.: Erlbaum.

Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation.* Cambridge: Cambridge University Press.

Means, B. (1994). Introduction: Using technology to advance educational goals. In B. Means (Ed.), *Technology and education reform: The reality behind the promise (pp.* 1-21). San Francisco: Jossey-Bass.

Office of Technology Assessment. US Congress. (1995). *Teachers and technology: Making the connection.* Washington, DC: US Government Printing Office.

Ross, B. (1991). Towards a framework for problem-based curricula. In D. Boud & G. Feletti (Eds.), *The challenge of problem-based learning (pp.* 34-41). New York: St. Martin's Press.

Seifert, E. H., & Simmons, D. (1997). Learning centered schools using a problem-based approach. *NASSP Bulletin,* S7(587), 90-97.

Savery, J. R., & Duffy, T. M. (1995). Problem based learning: An instructional model and its constructivist framework. *Educational Technology,* 35(5), 31-38.

Tanner, C. K., Keedy, J. L., & Galis, S. A. (1995). Problem-based learning: Relating the "Real World" to principalship preparation. *Clearing House, 68(3),* 154-157.

Topp, N. W., Mortensen, R., & Grandgenett, N. (1995). Building a technology-using facility to facilitate technology-using teachers. *Journal of Computing in Teacher Education,* 77(3), 11-14.

Waterman, R., Akmajian, P., & Kearny, S. (1991). Community-oriented problem-based learning at the University of New Mexico. Albuquerque, N.M.: University of New Mexico School of Medicine.

Whittaker, S. G., & Scheiman, M. (1996). Problem-based teaching in a didactic curriculum—A hybrid approach. *Optometric Education,* 27(4), 117-23.

Author

Barry N. Scott is a Doctoral Candidate in Instructional Technology at Auburn University. Thomas A. Brush is an Assistant Professor, Educational Media and Computers, Arizona State University.

A Systems Approach To Improving Technology Use in Education

Mark J. Toci
Kyle L. Peck

Abstract: Despite the power of emerging technologies to create engaging and meaningful learning environments, they have had little impact on the way we educate children. Because teachers are busy, isolated, practical people, the motivation to learn about and use technologies simply does not overpower the many existing obstacles. Obstacles including lack of time, availability of learning resources, and lack of incentives limit teachers' professional growth, preventing them from developing the knowledge, skills, and attributes necessary to integrate technology into the classroom. However, through a "systems approach" to the problem, it is possible to overcome these obstacles and to provide viable professional development to thousands of motivated teachers. This paper is a case study of one large-scale project using a systems approach to prepare teachers to use technologies well.

Resume: En depit des possibilites offertes par les nouvelles technologies pour creer des environnements d'apprentissage motivant et remplies de sens, elles ont eu un impact minime sur notre fa9on d'eduquer les enfants. Etant donne que les enseignants sont des gens occupes, isoles et pragmatique, leur motivation pour apprendre et utiliser les nouvelles technologies est nettement insuffisante pour surmonter les nombreux obstacles. Ces obstacles incluent le manque de temps, le manque de ressources pedagogiques et le manque de stimulants limitent la croissance professionnelle des enseignants, les empechant ainsi de developper les connaissances, les habiletes et les attributs necessaires a une integration des nouvelles technologies en salle de classe. Toutefois, une approche systemique fa9e au probleme permet de franchir ces obstacles et de fournir des possibilites de developpement professionnel viables pour les nombreux enseignants motives. Get article presente une etude de cas d'un projet a grande echelle utilisant une approche systemique pour preparer les enseignants a bien utiliser les technologies .

A Systems Approach to Improving Technology Use in Education

Modern electronic technologies are impressive "mind tools" offering the potential first to significantly improve, and then to *revolutionize* education. Around the world, educators and politicians are becoming aware of the potential of modern technologies in education. For example, in the United States, the Presidential Committee on Science and Technology (PCAST, 1997) recently reported that:

"Most researchers and practitioners in the field of educational technology are already convinced that information technologies have the potential not only to improve the efficacy of our current teaching methods, but perhaps more importantly, to support fundamental changes in those methods that could have important implications for the next generation...."

This potential, though widely acknowledged, is rarely realized in today's schools. While issues of access to technology are being addressed (slowly but surely), little progress has been made in addressing the other major roadblock - the inadequate preparation of educators to put these new tools to work, in either traditional or progressive ways. We need to change educators' attitudes and extend their technology-related capabilities before technologies will improve or transform education.

Unfortunately, technology education for teachers has largely been ineffective. Attempts at professional development for teachers often involve "one shot" sessions with visiting experts, or sessions that focus on isolated technology competencies without serious attempts to use the new skills and knowledge in the classroom, or to change teachers' belief systems (McKenzie, 1991; U.S. Department of Education, 1996). As a result, most teachers can operate computer technologies in basic ways, but they have not been inspired to go beyond the basics or to effectively integrate these new tools into student activities.

Hunt (1971) described two types of professional development. The first type involves incremental approaches designed to change specific teaching behaviors and strategies, while the other approach is aimed at shifting a teacher's belief system and actions. It is a relatively simple task to teach teachers how to use a new technology. It is a much more difficult task to cause teachers to change their belief systems, causing them to embrace new modes of operation in which the power of modern technologies can be realized. Professional development is generally "handled like a passing fad rather than an integral part of a long-term reform strategy." (U.S. Department of Education, 1996).

The purpose of this paper is to demonstrate that a "systems approach" to the design of professional development programming can overcome the tendencies to fragment programming. Systems Thinking during the design of professional development programs can result in a set of resources that encourage the long-term involvement and a shift in beliefs that will be a necessary prerequisite for meaningful reform.

Systems Thinking

"Systems thinking is a discipline for seeing wholes, recognizing patterns and interrelationships, and learning how to structure them in more efficient ways" (Senge & Lannon-Kim, 1991, p. 24). Systems thinkers consider the complexity of the organizations they are working to improve, in an attempt to understand how a change to one component is affected by and will affect other components of the system. Education, as an "open system" (Banathy, 1991), is made up of many complex parts that extend well beyond the walls of the school itself. Teachers, students, administrators, parents, businesses, taxes, curriculum, calendars, unions, laws, and relationships are but a few of the components that make up a school system. The ability of educators to effectively use technology in the classroom depends on would-be "change agents" taking a systemic approach to how they go about implementing and integrating technology. Reigeluth (1994) discusses the importance of a systemic view when approaching change in school systems:

Systemic change is comprehensive. It recognizes that a fundamental change in one aspect of the system requires fundamental changes in other aspects in order for it to be successful. In education, it must pervade all levels of the system: classroom, building, district, community, state government, and federal government. And it must include the nature of the learning experiences, the instructional system that implements those learning experiences, the administrative system that supports the instructional system, and the governance system that governs the whole educational system (p. 3).

As leaders of Pennsylvania's "Link to Learn Professional Development Project," we were responsible for the creation of resources that will lead to the effective use of learning technologies in schools. As systems thinkers, we assessed many factors that will influence the use of the products we create, and thought about the relationships among these factors. As a result of several planning sessions involving an Advisory Board composed of 35 representatives of schools, higher education institutions, and professional organizations, we concluded that effective use of technology in the classroom is dependent on three equally important factors: a) *availability* of the technologies; b) the *ability* of the professionals to use them well; and c) the *willingness* of educators to invest the energy and take the risks involved to change what they are doing. As a result, we realized that "access" to technologies was increasing rapidly and was not our responsibility, but that if we were to be successful, we must succeed in developing both ability and willingness. Ability without willingness produces people could achieve, but don't. Willingness without ability produces who people who try, but fail.

We realized that we could succeed only by developing and distributing products and services that cause teachers to want to engage in professional development and that lead to quick success, while teaching topics of importance to them and their students. If teachers and other professionals don't know how to use technologies or what to do with them to improve teaching and learning in their subjects, the investments in equipment, networking, and software are lost. Likewise, if teachers and others are *unwilling* to use them, the investments in tools and professional development are lost. Our analysis continued.

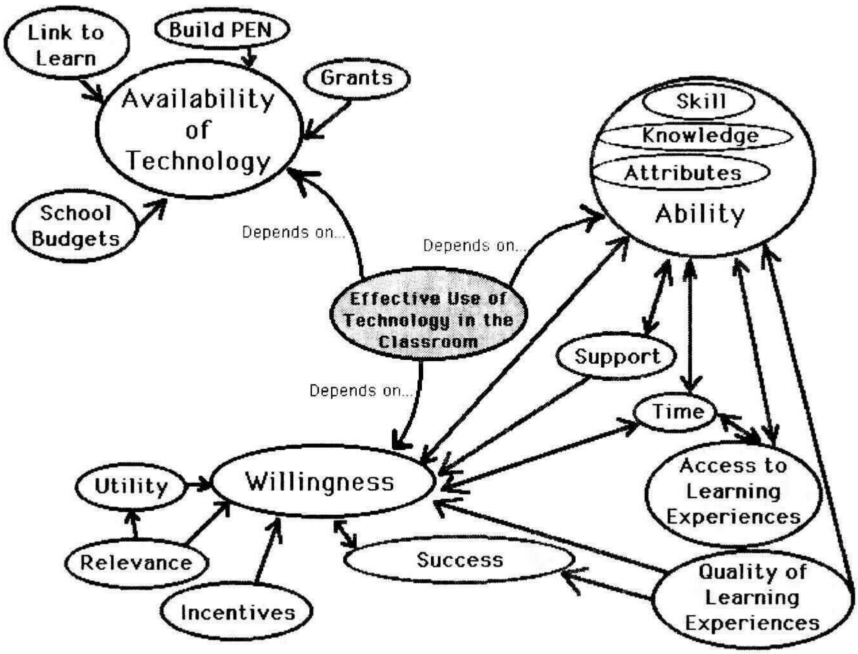
"Ability," we determined, consists of three major components, knowledge, skill, and attributes. Yes, computer users need to know "which buttons to push." They also need to know something about how computers work, how networks operate, and most importantly, how other educators in similar settings use these tools well. Teachers have little opportunity to see inside other classrooms, and even innovations implemented by teachers down the hall are often unknown to them. Important skills to be acquired are numerous, including obvious skill with different software tools, but more importantly skills like troubleshooting and on-line research skills.

"Attributes" that increase an educator's ability to use technologies effectively include characteristics like "independence," "self-discipline," "courage," and "confidence." Several agencies have completed technology initiatives only to find that despite large investments in hardware *and training*, there was little effect on what actually happened in the classroom. Teachers liked having the computers, and enjoyed the training and learned from it, but didn't take the next steps to incorporate these potentially powerful tools on a regular basis. Most computers in these classrooms display "dark screens" or screen savers most of the day, and get occasional use as a supplement to "business as usual." "Willingness" to use technologies is a critical component, most often overlooked. Great progress can be made by working wisely on this factor, with assistance from important organizations, which include teacher unions and school boards" associations.

Influencing Ability and Willingness

The diagram below (See Figure 1) illustrates some of the factors influencing the development and sustenance of ability and willingness.

Figure 1: Factors influencing the development and sustenance of ability and willingness.



How might we improve ability? Obviously, engagement in learning experiences - workshops, courses, on-line tutorials, instructional videos, books, and other sources of training and education can improve ability. The quality of the learning experiences will also effect the results. Less obvious is that fact that the "accessibility" of the experiences will influence their use. If we make these experiences increasingly available to educators, where they work and where they live for example, we can positively influence ability. The first question teachers ask when offered computer training or asked to use new technologies in their classrooms is, "Where am I supposed to find the time?" The "If you build it they will come" assumption is a dangerous one when dealing with educators. They are very busy people with little control over their time. They can't "block out a day" to learn how to use a new piece of software, and their evenings are generally occupied with family responsibilities, phone calls to parents, assessing student work, graduate-level coursework, and planning. Making time available will be a challenge, but will be a powerful contributor to the development of ability. (Ideas for creating time are presented later, as we discuss "willingness.")

Support is also a key variable in increasing ability. Teachers need to get quick answers as they wrestle with technological problems, or they will "bail out" and spend their time in other ways. For this reason, a high-quality support program will influence both willingness and ability.

How might we improve willingness? We must begin by acknowledging that educators are busy, dedicated, practical people and that, at first, it is more difficult to teach with technology than without it. If we are to cause educators to embrace technologies, we must increase the time they have, and support them as they take their first steps. In addition, we must make sure that their first steps lead to "quick success," - lessons in which increases in student learning justify the investment of time and energy. "Relevance" is another key issue. The ideas we promote for teachers must relate directly to things they care about - to important skills and knowledge they are expected to teach. "Utility," a concept related to relevance, refers to the "usability" of the proposal. Can it be done with minimal preparation time? Does it require equipment and software I can get quickly, easily, and preferably free?

Putting Systems Thinking to Work

A quick needs assessment revealed that although teachers believe technologies can significantly improve the effectiveness of education, they perceive that there is simply no time for professional development. Most teachers believe that time spent in professional development should be part of the contracted school day and year, or they should be compensated for the time they spend in professional development beyond the contracted service. Unfortunately, only a few days per year are allocated to professional development, and these days include startup time at the beginning of the year, time to produce report cards, and time to hold parent conferences, and they must include sessions on a variety of issues including, but certainly not limited to technology.

In its "School Technology and Readiness (STAR) Report," the CEO Forum on Education and Technology (1998), reported that only 13% of all public schools in the U.S. reported that technology-related training for teachers was mandated by the school, district or teacher certification agencies. The same report noted that 50% of teachers cited the "lack of time to train" when asked to rate the greatest barriers to integrating the Internet into the classroom.

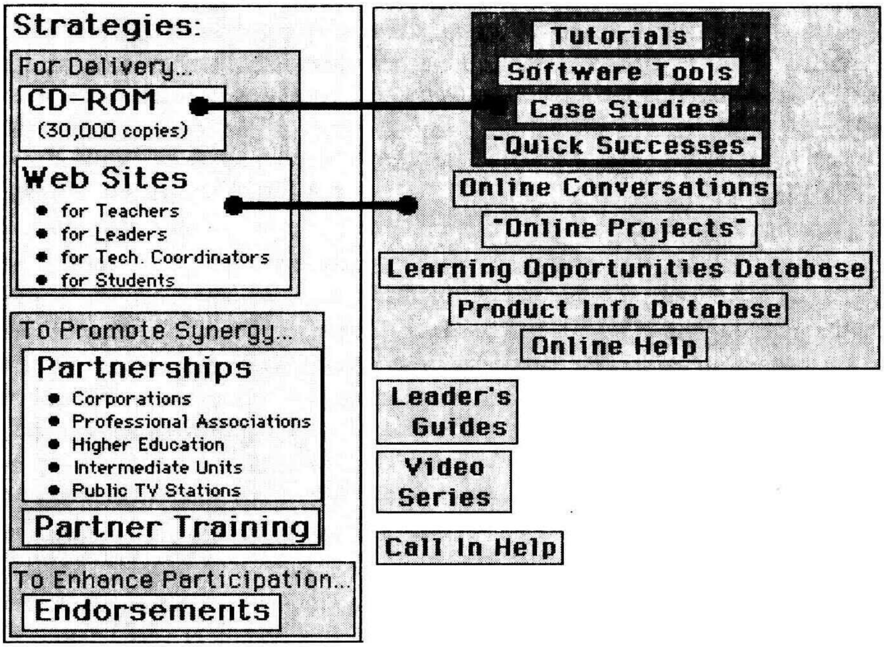
The amount of time that should be devoted to professional development *for technology issues alone* exceeds the total annual professional development time in the vast majority of school districts. The CEO Forum on Education and Technology developed professional development benchmarks for schools. In a "low-tech" school, by their definition, teachers get less than 30 hours per year of training related to the use of technologies, while in a "mid-tech" school teachers get between 30 and 50 hours per year, in a "high-tech" school they get between 51 and 70 hours of technology-related inservice, and in a "target-tech" school (the ideal) teachers would receive 71 hours or more of technology training each year. A survey published in the latest issue of Education Week shows that we are nowhere near that goal, reporting that only 15% of the nation's teachers received more than nine hours of technology-related training per year - an amount that is one-third of the lowest, "Low Tech" rating. Erik Fatemi, Senior Editor for Education Week's "Technology Counts" report said in an Associated Press interview, "The danger in not having teachers trained to use technology is that the money you spend on actual equipment can go to waste... If teachers don't know how to use it, it can just gather dust."

Teachers are busy, isolated, practical people. The base of professional knowledge and beliefs is changing rapidly, but educators have little time or opportunity to engage in professional development. A relatively small percentage of teachers push themselves to work a long day at school and then travel to attend a college or university course one or two evenings a week, but the percentage of teachers who choose to make this sacrifice (often spending as much time in their cars as in the classes they attend) is low. As a result, their professional growth is limited and their students' progress is constrained. The motivation to learn about and use technologies simply does not overpower the existing obstacles.

The Solution

Based on this understanding of what it will take to successfully address the complex problem of professional development for technology use and to accomplish the goals listed above, we developed a plan consisting of twelve products and five strategies, as shown in the diagram below.

Figure 2. Twelve instructional products and implementation strategies for developing technology skills.



Each product and strategy, and its purpose is described below.

Tutorials are comprehensive "lessons" designed to increase ability by developing skill and knowledge. We developed tutorials on the following topics, and published them in the form of a web site and CD-ROM:

- Beginning Guide to the Internet for Educators
- How to Use Netscape Navigator 3.01
- Integrating the Internet into the Curriculum
- Getting Started with Web Pages (HTML)
- How to Create Advanced Web Pages and Sites
- Using Multimedia Tools with the Internet

(These tutorials are available at: http://121.ed.psu.edu/linktuts/tutmain.htm)

"Software Tools" refers to a collection of shareware and trial versions of important software products, all gathered into a single location so that teachers would not be frustrated by missing pieces or by time-consuming searches and download time. The primary purpose of these tools was to increase ability by

providing educators with tools that expand what they can accomplish, and to improve willingness to engage by minimizing the time and frustration involved.

Case Studies are extensive looks at "Featured Teachers" who are using technologies in powerful ways. We produced a set of five in-depth case studies spanning a variety of subjects and levels, and developed in a consistent format. They may be useful individually, or as a set, because the featured teachers are asked a set of consistent questions and teachers can also follow responses to questions across case studies. (For an example of a case study, see http://121.ed.psu.edu/featured/intro.htm) The primary purpose of the case studies is to increase ability by expanding educators' knowledge, not of "how to," but of "what to" do with technologies.

"Quick Success Classroom Activities " are lessons designed to lead to successful implementation of networked computers with minimal preparation. More than 325 lessons demonstrating the effective use of technologies were created, spanning all subjects and grade levels. They consist of a "lesson plan," a student web page/worksheet, and a list of suggestions on how to extend the lesson into a unit or series of lessons. In addition, we created an on-line form through which teachers can expand this library. The Quick Success Classroom Activities serve several purposes: They build confidence, an attribute associated with ability; they build willingness by allowing early steps with technology to be pleasant and productive; they boost the perceived relevance of technologies by offering powerful lessons on things teachers consider important, and they improve teachers' perceptions of the utility of technologies because the amount of preparation is minimal and all required materials are provided. These classroom activities may be accessed through a menu and search engine located at: http://12l.ed.psu.edu/success/

We also created *On-line Conversations* to connect teachers with each other, forming virtual communities of educators with similar interests. We host conversations for teachers of all subjects and levels, as well as for professional organizations, colleges, universities, and our Department of Education's Technology Office. The purpose of these on-line conversations is to provide one level of support, to increase ability by sharing knowledge, and to promote early successes. (See: http://121.ed.psu.edu/confcen/discuss.htm)

Our *On-line Projects* serve mainly as incentives for effective technology use. These projects offer a series of interesting challenges for students and teachers, and promote collaboration among educators and their students throughout Pennsylvania. We host a set of on-line projects, titled "The Great Pennsylvania Quilt Factory," through which classes research problems, and post the results of their study in the form of web pages they create. We also host a project called "PA Picks" that encourages educators and their students to develop skills by creating an online database of copyright free images the students create and offer on line, with descriptions, keywords, and other information that make the images easy to retrieve. These projects may be seen at: http://l2l.ed.psu.edu/projects/ and http://121.ed.psu.edu/papicks/

To help educators find effective learning experiences, we created *"The Learning Opportunities Database."* Suppose, for example, that a teacher wants to learn how to create web pages. A visit to the database might reveal dozens of options, including the Link to Learn tutorial (available on line and on the CD-ROM), a two-day workshop offered by a local provider, a graduate level course, and a series of books on the subject. It might also show that Classroom Connect and Apple Computer will conduct workshops in school computer labs. Information on schedules and costs are provided, as are links to the providers and their products. The purpose of this database is to increase access to learning experiences, so that more learning takes place.

Because video is an effective way to capture emotion and to motivate viewers, we created a *video,* titled "The Kids and Wired," designed to help educators and others see the power of the Internet in the hands of students, and distributed it to public television stations across Pennsylvania and to 29 "Intermediate Units" that deliver media to schools. We allow educators to copy the video for educational purposes without contacting us, to promote the distribution of the information it contains, and we created a "Real Video" version of the 27-minut e video that is accessible through "video streaming" technology at:

To help educators understand how learning technologies can be put to use to transform the educational environment, we also offered a *Model* created by Dr. David Jonassen, that discuses how technologies can help make the classroom more active, responsible, constructive, collaborative, conversational, intentional, complex, contextual, and reflective. We have also added a few reports that help teachers see and understand effective applications of technology. We are also in the process of adding an *Online Conference Center* (http://l2I.ed.psu.edu/confcen/) through which we will offer digital versions of strong technology-related conference presentations to educators, who have few opportunities to attend conferences.

This series of strategic products is completed by two *Workshop Kits* that make it easier and less time consuming to offer effective workshops to other educators. Kits, titled "Browsing and Searching the World Wide Web" and "Publishing on the World Wide Web," include a printable Leader's Guide, online resources for students to use during the workshop, and handouts.

Delivery Strategies

30,000 copies of the *CD-ROM* containing these resources have been produced and distributed, and we are in the process of making another 30,000 copies of an updated version. The Link to Learn Professional Development *Web Site* (http://12l.ed.psu.edu/) contains more than 2,200 web pages and distributes all of the products mentioned above to anyone with Internet access at no charge. We currently receive approximately 3,500 "visits" each week. (A "visit" is a more accurate reflection of site use than the "hit" that is frequently reported. "Hits" count every graphic and page downloaded and result in an inflated impression of value. A "visit" reflects a user moving through the site. A second visit will not be recorded unless a user leaves the site for more than a half an hour and then returns.) The CD-ROM has proven to be a very inexpensive way to get this information into the hands of educators, and it makes these learning experiences available to teachers who do not yet have access to the Internet at home or in school. The Web Site is also an inexpensive way to distribute these materials, and is easily updated and expanded.

Synergistic Strategies

"Synergy" is the term used to describe a system when the value or power of the whole is greater than the sum of its parts. Our project can become stronger and can ensure its survival by engaging in "win/win" *partnerships* with other organizations, including corporations, professional associations, institutions of higher education, intermediate units, and public television stations. We have developed relationships with organizations in all of these categories, and are working to expand them. The critical importance of these relationships becomes evident when developing and implementing strategies to increase the use of the resources we have developed.

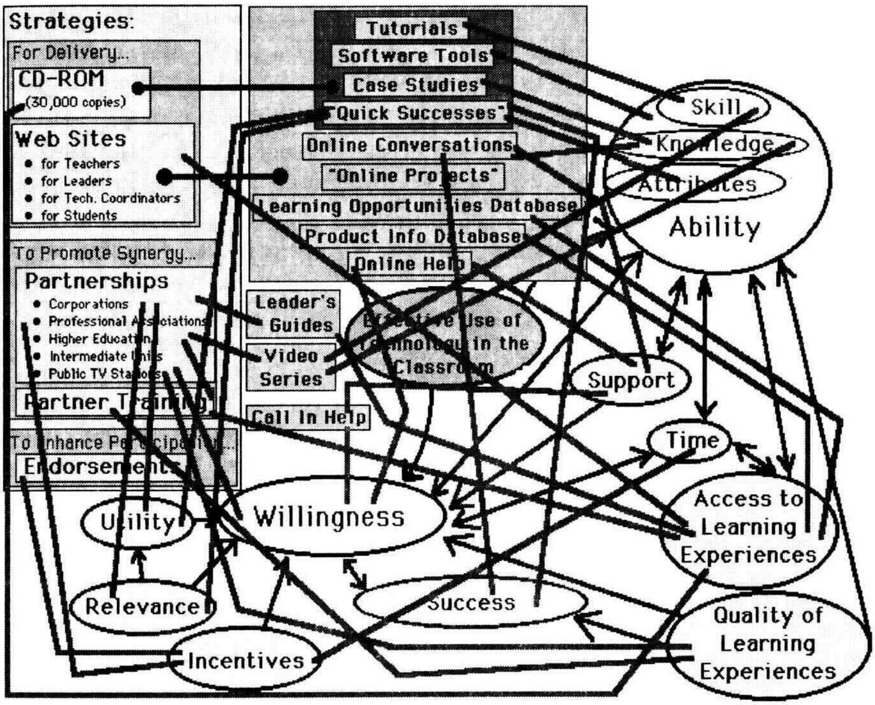
Our Advisory Board developed the concept of *"Technology Endorsements"* - statements describing what teachers of different subjects and levels should know about and be able to do with technology - as a strategy to get teachers and others to expand their understanding and use of learning technologies. Discussions with our Department of Education and other agencies have resulted in unanimous support of this concept.

As systems thinkers, we realize that while the concept of endorsements and incentives is potentially powerful, it is also potentially explosive. It must be handled in an appropriate manner, and it must be handled soon. If we do this well, we can influence the willingness of hundreds of thousands of teachers, causing them to "make time" to learn about and use technology. Incentives increase willingness, willingness increases time spent in learning, time spent learning improves ability, ability influences willingness, and the cycle continues. Add to increased willingness to participate access to effective learning experiences at home and at school, and you have the power to "turn the comer" and see progress beyond that accomplished to date.

Conclusion

As we said when introducing systems thinking, "'Systems thinkers consider the complexity of the organizations they are working to improve, in an attempt to understand how a change to one component is effected by and will effect other components of the system." The Link to Learn project looked at professional development for technology as a complex problem, identifying many interrelated variables and creating a solution that address the identified threats to success. Promoting the effective use of technology in education is a complex problem, for which there is no "silver bullet." If we are to make any real progress with technologies in schools, we must cover all the bases, working on all of the variables likely to promote and impede progress. As illustrated in the final (rather complex) image, our plan does that. As the lines that obscure the image demonstrate, our products are tied to the factors that lead to or prevent effective use of technologies in schools. The decisions we make as teacher educators will determine the value of our investments in technology, and more importantly, will influence the extent to which technologies improve the education of millions. In five to ten years we should begin to see the impact of this comprehensive strategy, and may be ready to make a stronger case for the use of systems thinking in the solution of educational problems.

Figure 3 Interactions between instructional products, strategies, and factors influence in ability and willingness.



References

Banathy, B. H. (1991). *Systems design of education.* Englevvood Cliffs, NJ: Educational Technology Publications.

CEO Forum on Education and Technology. (1998). School technology and readiness (STAR) report: From pillars to progress. Retrieved September 4, 1998 from the World Wide Web: http://wwvv.ceoforum.org/report97.

Hunt, D. (1971). *Matching models in education.* Toronto: Ontario Institute for Studies in Education.

McKenzie, J. (1991). Designing staff development for the information age. *From Now On: The Educational Technology Journal.4(\).* Retrieved September 4, 1998 from the World Wide Web: http://www.fromnowon.org/fnoapr91.html.

President's Committee of Advisors on Science and Technology: Panel on Educational Technology. (1997). *Report to the President on the Use of Technology to Strengthen K-12 Education in the United States.* Retrieved September 4, 1998 from the World Wide Web: http://www.whitehouse.gov/WH/EOP/OSTP/NSTC/PCAST/k-12ed.html

Reigeluth, C. M. (1994). The imperative for systemic change. In C. M. Reigeluth & R. J. Garfinkle (Eds.), *Systemic Change in Education* (pp. 3-11). Englewood Cliffs, NJ: Educational Technology Publications.

Senge, P., & Lannon-Kim, C. (1991). Recapturing the spirit of learning through a systems approach. *The School Administrator,* 23-28.

U.S. Department of Education. (1996). *Achieving the goals: Goal 4: Teacher education and professional development.* Retrieved September 4, 1998 from the World Wide Web: http://www.ed.gov/pubs/AchGoal4/.

Authors

Mark J. Toci is a Senior Instructional Designer at The Pennsylvania State University.
Kyle L. Peck is an Associate Professor at The Pennsylvania State University.

Technology' Across the Curriculum: The Teacher as Change Agent

James B. Ellsworth

Abstract: Emerging technologies can enhance the learning process. To realize this potential, they must be effectively integrated throughout the curriculum. Past applications of emerging technologies often focused on the mechanics of their use - failing to ever attain the impacts on learning for which they were designed. This paper explores research on systemic change and the diffusion of innovations, from the standpoint of Teacher Education. A framework is proposed which may be used to prepare teachers to take an active role in implementing emerging technologies, not as a subject unto themselves, but as a vehicle for exploring and mastering content and as a metacognitive tool. Specific attention is also paid to using these technologies to integrate academic disciplines through authentic, relevant activities.

Resume: Les nouvelles technologies peuvent rehausser le processus d'apprentissage. Pour realiser ce potentiel, elle doivent etre integrees dans tous le curriculum. Par le passe, les applications des nouvelles technologies ont eu tendances a etre centrees sur la pratique de 1'usage de I'instrument meme - empechant ainsi de profiler des veritables avantages pedagogiques prevus pour ces technologies. Get article explore la recherche sur le changement systemique et la diffusion de 1'innovation du point de vue de la formation des enseignants. Un cadre conceptuel est propose pour preparer les enseignants a prendre un role actif dans P implantation des nouvelles technologies, non pas comme un sujet d'etude mais plutot comme un vehicule servant a Pexploration et la maitrise de contenus et comme un outil metacognitif. Une attention particuliere sera aussi portee a 1'utilisation de ces technologies pour integrer les disciplines academiques par des activites authentiques et pertinentes.

Early efforts aimed at harnessing the power of emerging technologies to the tasks of teaching and learning frequently produced disappointing results. Students often mastered only the mechanics of a specific set of applications, or perhaps explored a particular subject - like history or geography - with the aid of a technology-based tool. Initial predictions of a technology-empowered education renaissance once again gave way to study after study showing "no significant difference" (Russell, 1997).

How can this be? Most educators have *seen* examples of effective technology use, have *experienced* its effects on students' learning. Why, then, do these effects fail to materialize in so much research...or in so many classrooms? Equally important, what can Teacher Education programs do to influence this process for the better? The answer, perhaps, lies less in the nature of the technologies themselves

Canadian Journal of Educational Communication. Vol. 27, No. 1. Pages 31 - 44. ISSN-0710-4340

than in the concept of their use with which future teachers leave preservice education (Oliver, 1994; Wetzel, 1993), and in the role we expect - and prepare - teachers to play in implementing innovations in their teaching (Hall & Hord, 1987).

Defining the Issues

The current paper frames the challenge of preparing teachers for effective use of emerging technologies on these two dimensions: the implementation of technology across the curriculum and the role of the teacher as change agent. In this context, the phrase "emerging technologies" is used to represent the set of technological innovations, having implications for teaching and learning, which are just beginning to achieve widespread implementation in the classroom.

In the discussion that follows, "technology across the curriculum" refers to building technology competencies through the use of emerging technologies as *tools* for the mastery of other skills and knowledge, as opposed to teaching of technology as an independent subject. The term "change agent" here refers to anyone who seeks to actively facilitate the adoption or implementation of an innovation - in this case, emerging technologies - as opposed to merely accepting the innovation themselves. The next two sections use these dimensions to make a case for a new framework for educating preservice teachers in the use of emerging technologies.

Technology Infusion: Practicing What You Teach

Around the world, "ideal" use of technology in education has evolved from "technology in the lab," where technology experts focused attention on mastering the technology itself to "technology across the curriculum," where teachers take ownership of the technology as a tool for conveying their subject matter (Pelgrum, Janssen Reinen, & Plomp, 1993). Yet the "traditional" Teacher Education program has continued to treat emerging technologies as a separate subject, covered in one or more required courses (Collis, 1996). Perhaps not surprisingly, experience with such traditional programs suggests that students often emerge with only a shallow understanding of how they might incorporate emerging technologies into their own teaching (Oliver, 1994; Wetzel, 1993). At the same time, institutions that have tried the new ideal - full integration of such instruction - have found that technologically inexperienced students may be left behind, overwhelmed by the demands of trying to master the technology concurrently with foundations or methods content (Kenny, MacDonald, & Desjardins, in press).

This has arguably been the classic dilemma of integrating instruction in emerging technologies across the Teacher Education curriculum. Effective Teacher Education programs must "practice what they teach" by modeling the use of emerging technologies, infused throughout the curriculum, as tools to enhance the learning process. Yet these programs must concurrently be able to accommodate the full spectrum of "technology savvy" among their students. Rogers (1995) notes that "The adoption of an innovation usually follows a normal, bell-shaped curve when plotted overtime on a frequency basis" (p. 257). If the technologies in question are, as defined earlier, "only beginning to achieve widespread implementation in the classroom," we can be confident that the adoption process has reached no farther than the early majority, leaving approximately 50% of prospective teachers with less-developed competencies in their use there (Rogers, p. 262).

This represents the first part of the challenge. Teacher Education must strike a balance between teaching emerging technologies by demonstrating their effective use in promoting mastery of *other subjects*, and ensuring that students in the late majority and beyond receive a baseline set of technology competencies before their lack of same would prevent them from mastering either the infused technology or the content it is used to teach.

Teacher-Driven Implementation: Educating Teachers as Change Agents

Assuming that a preservice Teacher Education program succeeds by this first measure, the next part of the challenge concerns *implementation* of what its students have learned. Hall and Hord (1987) suggest that many innovations are never really implemented as their developers originally conceived. Without an adequate understanding of the implementation process and its facilitation, teachers may react to resistance or other obstacles to change by attempting to bring an innovation into their classrooms with key components missing or seriously flawed. In such cases the innovation is never truly implemented, and much of its pedagogical benefit may be lost. Teachers with limited implementation competencies may also rigidly try to implement an innovation *exactly* as described, unwilling to modify components its developers might consider nonessential, even where such inflexibility may erode the support of key stakeholders.

Past wisdom dictated that such "reinvention" was simply inappropriate, but there may be cause to question this assumption (Rogers, 1995). After all, teachers are present in their classrooms on a day-to-day basis. They are in the best position, from a "data availability" standpoint, to assess and understand their students' needs. Ultimately, they are the ones with whom implementation of any potential solutions will rest. These facts would seem to argue for teachers playing a *leadership* role in implementing change in their classrooms - a role that might well include collecting feedback and using it to adapt innovations to those particular circumstances. This, in turn, requires the treatment of emerging technologies in preservice Teacher Education programs to be accompanied by some form of instruction in change facilitation.

Pulling it Together: Preparing Teachers to Lead Technology Infusion

At present, neither of these dimensions is often addressed by the preservice Teacher Education program. It is not uncommon for courses to advocate the view of technology as tool, rather than subject - but for emerging technologies to actually be *modeled* as across the curriculum is rare (Collis, 1996). Programs giving all prospective teachers a solid grounding in change agentry are even more difficult to find.

The current paper proposes an integrated framework for accomplishing these goals, based on the tenets of systemic change theory and the stages of concern described in the Concerns-Based Adoption Model (Hall & Hord, 1987), This approach is intended to serve two main purposes in regard to emerging technologies. First, it aims to structure teachers' preparation in the infusion of these technologies throughout their own practice in accordance with recent research findings. Second, it concurrently offers future teachers a unique opportunity to *observe* what application of these principles might look like in the classroom.

Designing the Framework

Teachers, technology, and change agentry may well be naturally converging as education copes with present realities and future requirements. In 1990, Hughes suggested that a shortage of teachers in Canada could be ameliorated if teachers were prepared to make innovative use of emerging technologies to facilitate learning and motivation. Yet, as noted earlier, prospective teachers may enter their preservice training with any level of technological competence and confidence - so designing a "one size fits all" program to offer this preparation may seem problematic.

However, looked at another way, students undergoing such training may be viewed as a cross-section of the environment that awaits them in their first teaching assignments. As *they* first begin to teach, they will find some students (and colleagues) are more skilled with technology, and some are less. Consequently a Teacher Education curriculum that addresses this varied background developmentally - as teachers enhance their own competencies in integrating emerging technologies - *will also teach change agentry* by modeling such an approach, which graduates can ultimately use to infuse these technologies into the curricula of their own schools.

To the scholar of educational change, this description alone may call to mind the Concerns-Based Adoption Model (CBAM). First proposed by Hall, Wallace, and Dossett (1973), CBAM is the only major model of change that is both developmental *(i.e.,* built around a generally progressive series of stages) and focused expressly on teachers. If one considers the preparation of tomorrow's teachers to integrate emerging technologies in their instruction as, essentially, persuading them to *adopt* these technologies as tools for teaching and learning, the relevance of such a model becomes especially clear. Because CBAM focuses the change process on the perceived needs of the adopter, this approach has the added advantage of addressing a shortfall of many earlier diffusion efforts: "...change facilitators [basing] their interventions *(i.e.,* what they did) on their own needs and timelines rather than on their clients' needs and change progress" (Hall & Hord, p. 5).

Three diagnostic dimensions are available in CBAM: Stages of Concern, Levels of Use, and Innovation Configurations (Hall, 1978). Within the scope of this paper, it is the first of these, Stages of Concern (SoC), that will offer the most insight for addressing emerging technologies in Teacher Education. The table illustrates CBAM's SoC dimension. At Stage 0 (Awareness), teachers may know the innovation exists, but express no interest in it. At Stage 1 (Informational), teachers begin to seek additional knowledge about the innovation. In Stage 2 (Personal), teachers are concerned with how the innovation will directly affect *them* as with the mechanical aspects of innovation use in their teaching. Only at Stage 4 (Consequence) do teachers first begin to focus on the impact of their innovation use on their students' learning. At Stage 5 (Collaboration), teachers' concerns begin to consider how they could *enhance* this impact by deliberately coordinating their innovation use with one another. Finally, at Stage 6 (Refocusing), teachers begin to consider the "next cycle" - what *new* innovation(s) might better address the need for which the current innovation was adopted (Hall & Rutherford, 1983).

Table 1: Stages of Concern

Stage 0	Awareness
Stage 1	Informational
Stage 2	Personal
Stage 3	Management
Stage 4	Consequence
Stage 5	Collaboration
Stage 6	Refocusing

Using these stages as a guide, then, the sections that follow set out a possible framework for modeling both appropriate technology use and change facilitation practice across the Teacher Education curriculum. An introductory technology course *is* recommended, to offer students with limited technology competencies the foundational skills and knowledge they will need to keep up with an infused curriculum. At the same time, this course is designed to offer equal benefit to students who arrive having already mastered these competencies, by allowing them to progress to the next stage: practicing their application in instructional settings.

The Introductory Course: Building Technology Competencies

Beginning at the beginning, students' first introduction to emerging technologies in the context of the Teacher Education program must recognize that some will be entering at SoC 0 (Awareness). Those at this stage may know that these technologies exist, and are sometimes used in teaching and learning. However, they have no experience with so much as the rudiments of their use in the classroom, may lack even basic skills like mouse and keyboard use, and do not consider technology to be personally relevant. Others will be at SoC 1 (Informational). They are aware of technology's importance in educational settings, and want to know more - but have yet to make a decision about their own use (Hall & Rutherford, 1983). They too are inexperienced in classroom use of technology, although early information-gathering activities may have led them to have some exposure to basic technology skills and concepts. In the information-rich environment of Teacher Education, movement through these stages is likely to be rapid and relatively smooth.

Some, however, will enter the program at SoC 2 (Personal). These individuals have acquired enough information concerning emerging technologies to begin to question their ability to cope with their requirements, or to wonder about the personal consequences of failure to adequately master their use in the classroom. Those who have passed this stage and are at SoC 3 (Management) have passed an important hurdle, but will consider just *using* technology in the classroom to be highly demanding, and may wonder how they are expected to actually *teach* at the same time. Addressing the issues associated with these stages is considerably more complex.

Coping with this range of concerns and needs in a single course is certainly a challenge. Fortunately, a few strategies are available, and have experienced some success. A first step is finding out where your class stands. Hall, George, and Rutherford (1986) have developed and validated a questionnaire and associated manual for measuring Stages of Concern. Use of this instrument allows profiling of individual students, and design of appropriate interventions for addressing their varying needs.

As mentioned previously, some students will already be experiencing Management (SoC 3) concerns. They require practice, to refine and build confidence in their ability to manage emerging technologies in their classroom - and what better way to offer this than to recruit them as peer tutors for those at earlier stages? Students in these programs are, after all, learning to be teachers; assisting peers who have less technology background will prepare them to cope with the varying levels of experience they will encounter in their own classrooms (Kovalchick, 1997).

Helping peers who are experiencing the Stages of Concern that *they* recently passed through will also help them deal with the concerns they will subsequently encounter in the faculty lounges of their future schools, as they seek to enhance the climate for technology use among their fellow teachers. Finally, as other researchers note, the fact that students may be inexperienced in the use of emerging technologies *as teaching tools* does not necessarily preclude them surpassing even the professor in their *general* use. Employing students who may be experts at (for example) tracking their favorite rock group on the Web to help their classmates locate *educational* resources will free faculty to focus on the pedagogy that is the heart of the content they are teaching (Duffield, 1997).

Operationalizing these strategies in the classroom, of course, can be complex. One interesting approach to doing so has been explored by Brown and Henscheid (1997), who have developed the "PIG Continuum." The authors explain that "PIG stands for Presentational, Interactive, and Generative uses of technology, meaning that students can watch multimedia presentations (P), interact with simulations and/or each other (I), or make or generate their own presentations (G)" (Brown & Henscheid, p. 17). In the context of the framework being described here, the peer tutors (students whose concerns primarily relate to SoC 3, Management) discussed above would most likely welcome the Generative opportunities, getting practice using technology to create and deliver the presentations being watched by their counterparts at SoC 0 (Awareness) and 1 (Informational) - who would be grateful for the information gained from observing such Presentational uses. Meanwhile, students experiencing Personal (SoC 2) concerns would have the opportunity to discuss them with one another - and with classmates who have recently resolved those concerns - during Interactive use, to observe classmates developing their competencies by observing Presentational use, and ultimately to try it themselves in Generative use. In fact, the authors note (p. 17) that PIG *is* a continuum because overlaps are also possible - meaning that a particular group of students could successively view a multimedia presentation, interact to discuss their personal concerns with each other and a peer tutor, then collaboratively generate their own presentation for the class.

The PIG Continuum also combines well with the use of technology portfolios suggested by Kovalchick (1997). Such portfolios could be developed through a series of Presentational-Interactive-Generative "rotations" (each focused on a particular teaching/learning technology) and would provide a useful and authentic assessment tool as well as the opportunity for metacognition and reflective practice she describes (pp. 32-33).

Beyond the Basics: Getting Comfortable With Classroom Use

Having completed such an introductory course, all students should now possess basic technological competencies at a level that will enable them to focus on the *application* of emerging technologies to teaching and learning in the integrated curriculum that follows. Nevertheless, even the most advanced students (those *entering the* introductory course already experiencing Management concerns) will have only limited experience applying these technologies to teaching in brief, isolated exercises. Those who entered the program at an earlier stage of concern will require even more additional practice beyond the introductory course. To satisfactorily resolve the remaining "mechanics of use" concerns all students will be experiencing at the end of the introductory course, the program must follow it up with activities to ground its lessons in the "bigger picture" of the classroom.

Within the "technology infusion" approach, excellent opportunities for accomplishing this can be found in courses teaching lesson planning or curriculum development. Students in each of these subjects can engage in exercises to actually *develop* a lesson that includes technology, or plan technology-enhanced projects to support particular portions of a curriculum they design. Such activities give students the chance to further refine their use of technology in their teaching, build confidence in their ability to successfully manage a technology-enhanced classroom, and let them see how emerging technologies can work as a part of an actual teaching event or strategy.

In fact, formal models are beginning to emerge for doing just this. Among the most notable is the "iNtegrating Technology for inQuiry" model, or NTeQ (Morrison, Lowther, & DeMeulle, in press). Using NTeQ in lesson planning instruction provides an authentic context in which students can study, plan, and deliver instruction incorporating emerging technologies in educationally meaningful ways. This model is especially powerful in the Teacher Education context because it involves the teacher acting as facilitator of inquiry, rather than dispenser of knowledge, by *modeling* cognitive and physical processes. Thus, teacher educators who use NTeQ-planned lessons to teach students to design technology infused lessons are once again modeling processes their graduates will find useful in their own teaching practice.

Another interesting perspective is provided in a recent study by Oliver (1997) of 79 K.-12 Internet projects. Oliver's findings represent a possible taxonomy of Internet-enhanced activities within a project-based curriculum. While activities are included from every stage of a project life cycle, teachers should probably not be encouraged to plan entirely Internet-based projects. Oliver notes, in fact, that "...not all [activities] are present in every project" (p.33). This raises the possibility that his taxonomy might be most useful as an "a la carte" menu from which specific Internet-based activities can be selected *as part* of a project, where that medium facilitates a more powerful learning experience than would otherwise be available.

Assessing Impact: Forging the Link to Outcomes

Once students have satisfied their Management (SoC 3) concerns regarding their ability to successfully handle the time and procedural issues associated with technology use in the classroom, the next phase of instruction in the technology infused curriculum can focus on Consequence (SoC 4) concerns. These concerns are likely to express themselves as one of two questions: "How do I use technology to *improve* student learning," or "How do I tell if student learning *has improved."*

In the first category, the technology across the curriculum approach might suggest incorporating technology-based alternatives into educational methods classes. Where such classes may have traditionally expounded on the situations in which lectures, self-study, or group work might be most effective, they might now also cover the circumstances in which emerging technologies allow the teacher to do what could not previously be done, or to involve people who were never before reachable (Ellsworth, 1997). Such exposure will help equip tomorrow's teachers to make informed decisions about when to use technology and when a more traditional tool might be more effective - and to help *their* students construct their own rubrics for making these decisions in their everyday lives.

In the second category, an obvious home for such instruction within the technology-infused curriculum is in courses on evaluation and assessment. A second possibility is in classes dealing with applicable educational standards. Such instruction might cover use of test construction software, spreadsheets, or statistical analysis packages. Perhaps the best way to involve technology in assessment across the curriculum, however, is to employ it *across the curriculum.* In a Teacher Education program where technology is a vital tool within every course, it carries with it the innate advantage of helping students create *and store* their products - the evidence of their learning.

This suggests a portfolio assessment strategy, or even "Graduation by Exhibition" - alternative techniques for measuring student achievement through critical evaluation of authentic products that are rapidly gaining a following in a variety of educational settings (Tiedemann, 1996). Such assessment is an especially crucial component under the technology infusion approach, as without a formal requirement for students to demonstrate their mastery prior to graduation, technology competencies spread across the curriculum may receive only cursory attention compared to the foundations and methods objectives for which students *are* held accountable.

An interesting combination of *both* categories is advocated by Kovalchick (1997), who advocates using "technology portfolios" as *an instructional strategy* in a reflective approach to Teacher Education. Her suggestion that portfolios - in addition to their more obvious use as an assessment mechanism - inherently facilitate positive learning outcomes is also supported by other research, which argues that the process of their *development* builds student motivation and ownership, and encourages reflective practice (Barton & Collins, 1993; Shackelford, 1996; Wade & Yarbrough, 1996).

Building Bridges: Interconnecting the Infused Curriculum

As teachers grow more adept at effective use of an innovation to promote learning, and more skilled at assessing the level of learning that has in fact occurred, CBAM research has found that they may begin considering how they could *intentionally coordinate* their use with other teachers to amplify these effects (Hall & Rutherford, 1983). Such Collaboration (SoC 5) concerns go beyond simply being aware that another teacher is covering a particular subject, and incorporating that into one's own course. Thus, Teacher Education faculty who want to *encourage* this collaboration must provide their students with skills and techniques to recruit other faculty members and engage them in productive, coordinated planning and teaching. Note that this does not have to involve team teaching, *per se,* although that is of course an option. Collaborative efforts can be as simple as joint lesson or curriculum planning - to identify areas where each participating teacher can tie in with what others are doing - or as complex as entire learning systems designed to interconnect *all* instruction (Tiedemann, 1996).

Once again, *teaching* strategies for collaboration, within a technology infused Teacher Education curriculum, offers an opportunity for *modeling* these same strategies for students. Many teacher educators have found that coordinated planning helps to ensure that all intended technology competencies *are in fact taught* - despite being distributed across several courses taught by multiple faculty members - and facilitates use of exercises covering related competencies to reinforce one another (Rodriguez, 1996). It is also worth noting that such coordination, in addition to identifying opportunities *forfaculty* collaboration, may also identify possible areas for *students* in different classes to collaborate in group projects requiring the competencies being learned in multiple courses - modeling the sort of cross-disciplinary cooperation they will encounter throughout their working lives.

Learning to Evolve: Creating an Adaptive Educational System

Recognizing the fact that change, in "real world" settings, is never complete, CBAM's final Stage of Concern, Refocusing (SoC 6), deals with "next steps." Once teachers are effectively using a given innovation to enhance learning, and coordinating their individual uses to further increase its impact, they are likely to begin considering what other, *new* innovations might help them improve their students' learning *more* (Hall & Rutherford, 1983).

When one considers the preparation of tomorrow's teachers in the area of emerging technologies, providing them with skills and techniques to facilitate refocusing must not be neglected. Many of today's teachers (and teacher educators) can remember when overhead and filmstrip projectors - and perhaps programmed texts - were "state-of-the-art technologies." Today, after perhaps attempting to discard these tools as "outdated," educational technologists are fast realizing that the addition *ofnew* tools does not necessarily allow (much less *require)* them to discard any *oldtooh* (Betz & Mitchell, 1996). Discussion of this problem, and of potential strategies for alleviating it, is growing more common in the Teacher Education literature (Smaldino & Muffoletto, 1997). With the tools at one's disposal multiplying, it will soon no longer be possible to provide future teachers with sufficient exposure to *all* of them to be useful. Instead, what is likely to be more productive is a *process* approach that emphasizes reflective practice, critical thinking, and media selection strategies. Such preparation will enable new teachers to examine *any* new technology as it emerges, to identify its most salient characteristics, strengths, and weaknesses, and to decide how best to incorporate it into their own teaching practice (if at all).

Tying It All Together: "Zooming Out" to the Big Picture

In describing the Elaboration Theory of Instruction, Reigeluth and Stein (1983) use the analogy of a zoom lens to illustrate the importance of providing a peek at the context within which a given block of instruction is situated as an organizer before proceeding with that instruction - and of returning to that "big picture" again once the instruction is complete. This was an important foreshadowing of Reigeluth's later involvement in the Systemic Change movement (Reigeluth & Garfinkle, 1994), as it recognizes the interrelationships between each level of instruction and its various components in a learning *system.* In essence, the entire notion of technology across the curriculum is inherently systemic, as it seeks to place technology instruction and practice conceptually adjacent to the types of teaching and learning activities they most effectively support.

Consequently, as students conclude their preservice Teacher Education, it is important to review with them the technology preparation they have received, to highlight relationships between techniques and strategies that they may not have been able to perceive while immersed in them. Continuing with an integrated approach, such a review might fit well in a curriculum course, where a technology-infused curriculum could serve as a case study: Alternatively, it might be placed in the capstone course discussed in the next subsection, reviewing the Teacher Education curriculum and preparing students for the practice teaching experience.

Curricula supporting the former approach already exist, in the case of primary and middle school settings. At the primary level, Project CHILD (Computers Helping Instruction and Learning Development) is an outstanding example that has already produced significant positive results (Butzin, 1997). At the middle school level, another initiative called Project TEAMS (Technology Enhancing Achievement in Middle School) shows similar promise. The TEAMS curriculum contains four nine-week thematic units with themes selected for relevance to middle school students (transitions, caring, identities, and conflict resolution). Each unit incorporates several "rotations" in which the subject areas of science, mathematics, social studies, and language arts are related to the theme currently being studied. Technology is integrated into every rotation as a tool to facilitate particular learning activities (Reiser & Butzin, 1998).

Use of case studies showing application of the technology infusion principles students have learned during their Teacher Education program will help to anchor those lessons in a context that is personally relevant to each student. This approach would be even more effective if a similar technology infused curriculum was available at the high school level; students could then be shown the general concepts of technology integration as a class, then grouped by the level that they were preparing to teach for case study based activities, and perhaps brought back together for a synthesis and comparison of findings at the end.

The Capstone Course: Reinforcing Technology Leadership

The preceding sections have focused on developing prospective teachers' abilities to make appropriate and effective use of emerging technologies. The current paper also declared another objective as it began: developing those teachers' abilities to act as *leaders for change* in their schools, to work with their future colleagues to facilitate equally effective application of these technologies as tools for teaching and learning throughout the entire curriculum.

A major focus underlying this paper throughout the preceding sections as well has been the use of the Teacher Education curriculum *itself as* an opportunity to *model* principles of change facilitation, grounded in the Concerns-Based Adoption Model's "Stages of Concern," for that curriculum's students. At this point, when (hopefully) these students have successfully experienced most of these stages, and learned techniques for facilitating progression through them, it may also be useful to provide specific instruction in change leadership, perhaps as part of a capstone foundations course. As the program draws to a close, such instruction could use the students' *own experiences* during their studies to illustrate the efficacy of the CBAM-based approach. In this fashion, the Teacher Education program can make a final contribution toward preparing its graduates to take an active role in helping their schools make appropriate use of emerging technologies as tools for teaching and learning.

Supporting Critical Reflection in Adoption

The preceding discussion has focused on preparing future teachers to infuse emerging technologies into their teaching, and across the curriculum - in essence, *to adopt* - and in fact to lead this process: *to facilitate implementation.* It has given only limited attention to the antecedent question of whether an innovation *should* be implemented - a vital and oft-neglected issue noted by Rogers (1995) and by several critical theorists (Habermas, 1969; Wajcman, 1991).

It should be noted from the outset that posing such a framework in "pro-innovation" terms is not intended to suggest that teachers should be trained to implement any proffered technology uncritically. On the contrary, it seems reasonable that *seeing* emerging technologies modeled in effective classroom use throughout their preservice preparation would facilitate teachers' critical evaluation of *future* technologies by offering an experiential basis for evaluating their contribution to teaching and learning; such reflection is to be strongly encouraged.

References

Barton, J., & Collins, A. (1993). Portfolios in Teacher Education. *Journal of Teacher Education, 44(3),* 200-210.

Betz, M. & Mitchell, J. (1996). Ed Tech in Teacher Education: Curricular Space Required. *Journal of Technology and Teacher Education, 4(3/4),* 181-195.

Brown, G., & Henscheid, J. (1997). The Toe Dip or the Big Plunge: Providing Teachers Effective Strategies for Using Technology. *TechTrends, 42(4),* 17-21.

Butzin, S. (1997). Whatever Happened to Project CHILD? *Learning and Leading with Technology, 24(6),* 24-27.

Collis, B. (1996). Technology in Teacher Education. In T. Plomp and D. Ely (Eds.), *International Encyclopedia of Educational Technology* (2nd ed.) (pp. 534-538). Oxford: Elsevier Science Ltd.,.

Duffield, J. (1997). Trials, Tribulations, and Minor Successes: Integrating Technology into a Preservice Teacher Preparation Program. *TechTrends, 42(4),* 22-26.

Ellsworth, J. (1997). Curricular Integration of the World Wide Web. *TechTrends, 42(2),* 24-30.

Habermas, J. *(\969). Toward a Rational Society: Student Protest. Science and Politics.* Boston. MA: Beacon.

Hall, G. (1978, March). *Implications for Planned Dissemination, Implementation, and Evaluation Revealed in the SRI/NDN Evaluation and Levels of Use of the Innovation Studies.* Paper presented at the Annual Meeting of the American Educational Research Association, Toronto, Ontario, Canada.

Hall, G., George, A., & Rutherford, W. (1986). *Measuring Stages of Concern About the Innovation: A Manual for Use of the SoC Questionnaire.* Austin, TX: Southwest Educational Development Laboratory.

Hall, G. & Hord, S. (1987). *Change in Schools: Facilitating the Process.* Albany, NY: State University of New York Press.

Hall, G. & Rutherford, W. (1983/ *Client Concerns: A Guide to Facilitating Institutional Change.* Austin, TX: The University of Texas at Austin, Research and Development Center for Teacher Education.

Hall, G., Wallace, R., & Dossett, W. (1973). *A Developmental Conception of the Adoption Process Within Educational Institutions* (Report m 3006). Austin, TX: The University of Texas at Austin, Research and Development Center for Teacher Education.

Hughes, A. (1990). *Success for Every Child: The Teachers We Need for the 1990s and Beyond.* Syracuse, NY: Educational Resources Information Clearinghouse. (ERIC Document Reproduction Service No. ED 3 19 708).

Kenny, R., MacDonald, C., & Desjardins, F. (1998). The Integration of Information Technologies for Facilitating Learning: Redesigning the Teacher Education Curriculum at the University of Ottawa. *Canadian Journal of Educational Communication, 26(2),* 107-124.

Kovalchick, A. (1997). Technology Portfolios as Instructional Strategy: Designing a Reflexive Approach to Preservice Technology Training. *TechTrends, 42(4),* 31-36.

Morrison, G., Lowther, D., & DeMeuIle, L. (in press). *Integrating Computer Technology into the Classroom.* Englewood Cliffs, NJ: Merrill/Prentice Hall.

Oliver, K. (1997). Getting Online with K-12 Internet Projects. *TechTrends, 42(6),* 33-40.

Oliver, R. (1994). Information Technology Courses in Teacher Education: The Need for Integration. *Journal of Information Technology for Teacher Education, 3(2),* 135-146.

Pelgrum, W., Janssen Reinen, I, & Plomp, T. (1993). *Schools, Teachers, Students and Computers: a Cross-National Perspective.*_TIie Hague: International Association for the Evaluation of Educational Achievement.

Reigeluth, C. & Garfinkle, R. (Eds.). (1994;. *Systemic Change in Education.* Englewood Cliffs, NJ: Educational Technology Publications.

Reigeluth, C. & Stein, F. (1983). The Elaboration Theory of Instruction. In C. Reigeluth (Ed.), *Instructional-Design Theories and Models: An Overview of Their Current Status* (pp. 335-381). Hillsdale, NJ: Lawrence Erlbaum Associates.

Reiser, R. & Butzin, S. (1998). Project TEAMS: Integrating Technology into Middle School Instruction. *TechTrends, 43(2),* 39-44.

Rodriguez, S. (1996). Preparing Preservice Teachers to Use Technology: Issues and Strategies. *TechTrends, 41(4),* 18-22.

Rogers, E. (1995). *Diffusion of Innovations,* Fourth Edition. New York: The Free Press.

Russell, T. (1997). *The "No Significant Difference" Phenomenon* (4th ed). Raleigh, NC: North Carolina State University. [On-line]. Available at http://tenb.mta.ca/phenoiTi/phenom.html

Shackelford, R. (1996). Student Portfolios: A Process/Product Learning and Assessment Strategy. *The Technology Teacher,* 55(8), 31-36.

Smaldino, S. & Muffoletto, R. (1997). The Education Media Experience in Teacher Education. *TechTrends, 42(4),* 37-40.

Tiedemann, D. (1996). New Florida School Celebrates Education and Technology: An Interview with Paul Kraft, Media Specialist for Celebration School. *TechTrends, 41(4),* 14-18.

Wade, R., & Yarbrough, D. (1996). Portfolios: A Tool for Reflective Thinking in Teacher Education? *Teaching & Teacher Education, 12(\),* 63-79.

Wajcman, J. (1991). *Feminism Confronts Technology.* University Park, PA: Pennsylvania State University Press.

Wetzel, K. (1993). Models for Achieving Computer Competencies in Preservice Education. *Journal of Computing in Teacher Education, 9(4),* 4-6.

Author

James Ellsworth is Communications Officer, Division for Systemic Change, the Association for Educational Communications and Technology.

Training Teachers for Success: Pre-Service Teachers and Technology Integration

Karen L. Rasmussen
SueNorman

Abstract: Today's teachers are challenged with integrating technology into their classrooms. National and state initiatives have provided guidelines for colleges of education regarding teacher training and the use of technologies. One model for preparing pre-service teachers for these challenges involves a technology component sequence in which students develop basic technology skills, observe technology in the classroom, implement lessons, and reflect upon their experiences. This model involves a combination of college-classroom experiences and field experiences to ensure that tomorrow's teachers possess the skills they need to successfully integrate technology into their classrooms.

Resume: Les enseignants d'aujourd'hui sont confrontes a 1'integration des nouvelles technologies dans leurs classes. Les initiatives des divers paliers gouvernementaux ont fourni des lignes directrices aux colleges d'education au sujet de la formation a I'enseignement et 1'exploitation des nouvelles technologies. Un des modeles de preparation des etudiants-maitres pour ces defis implique une sequence de composantes technologiques qui leurs permet de developper des habiletes technologiques de bases, d'observer ces technologies en classe, d'implanter des lessons et finalement de reflechir sur leurs experiences. Ce modele implique un combinaison d'experiences en classe au college ainsi que des experiences en milieu scolaire afin d'assurer que les enseignants de demain auront les competences necessaires a la reussite de 1'integration des nouvelles technologies en classe.

Training Teachers for Success: Pre-Service Teachers and Technology Integration

A critical element of the pre-service teacher experience involves the use of technology. Within an integrated technology Teacher Education program, future teachers can develop the technology skills they need to integrate technology into the curriculum. Historically, teachers have been ill-prepared to use and integrate technology into their classrooms (U.S. Congress, 1995), even though teachers who effectively use technology can improve students learning experiences (Braun, Moursund, & Zinn, 1992). Strategies for training teachers in the use of technology must be incorporated into pre-service education to prepare them for future challenges offered by reform and accountability initiatives. Pre-service teacher programs with integrated technology components can ensure that future teachers are adequately

Canadian Journal of Educational Communication, Vol. 27, No. I, Pages 45 - 56,1SSN-0710-4340

prepared for the classrooms of the 21st century' (Northrup & Little, 1996).At the University of West Florida (UWF), the basis for technology integration strategies is founded upon benchmarks for technology and integrated curricula. National U.S.A. entities that provide guidance to Teacher Education programs include the National Council for the Accreditation of Teacher Education (NCATE), the International Society for Technology in Education (ISTE), and the U.S. government, in its SCANS (Secretary's Commission on Achieving Necessary Skills, 1991) Report and in Goals 2000 (Northrup & Little, 1996; Peck, 1998). Other North American governments have also developed standards such as the Employability Skills for British Columbia (AETT, 1995).

The technology component of the pre-service education program at UWF emphasizes ISTE standards, focusing on three areas: foundations, personal and professional use of technology and application of technology in instruction (ISTE, 1998). Specific tasks support each area and technology outcomes are aligned to these tasks. The purpose of this paper is to describe the technology component of this innovative pre-service teaching program.

In Florida, standards for student and teacher performance are also based on the goals of Blueprint 2000, Florida Sunshine State Standards (SSS) and the Teacher Accomplished Practices (Florida Education Standards Commission, 1996). Florida's Blueprint 2000 addresses goals for Florida's schools. Goal 3 refers to student (i.e., children's) performance and outcomes which are categorized in areas of: Information Managers, Effective Communicators, Numeric Problem Solvers, Creative and Critical Thinkers, Responsible Workers, Resource Managers, Systems Managers, Cooperative Workers, Effective Leaders, and Culturally Sensitive Citizens. Throughout the SSS, outcomes for technology skills are infused into eight subject areas (Language Arts, Mathematics, Social Studies, Science, Foreign Languages, the Arts, Applied Technology, and Health and Physical Education) (Florida Department of Education, 1996).

There are twelve Accomplished Practices listed for Florida teachers. Accomplished practices describe the skills that teachers should display at the pre-professional, professional, and accomplished levels of performance. The Accomplished Practice for technology indicates that teachers will use appropriate technology in the teaching and learning process. At the pre-professional level (i.e., graduates of pre-service Teacher Education programs), pre-service teachers are expected to use available technology that is appropriate for the learner, provide students with opportunities to use technology, facilitate access to electronic resources, and use technology to manage, evaluate, and improve instruction (Education Standards Commission, 1996). Table 1 outlines state-suggested indicators, pre-professional requirements, and activities that meet those indicators. Also included are the technology classes where those skills are primarily taught.

The skills learned in UWF technology-focused courses are practiced and reinforced throughout the pre-service teachers' course of study. Technology is widely integrated across the entire curriculum, in knowledge-based courses and methods courses. Throughout the college, faculty model the use of technology and require students to use technology for course assignments, projects, and communication. To assist in this modeling, extensive summer faculty development initiatives have been implemented to ensure that faculty have the skills that they need to integrate technology into their own classrooms.

Underlying the skill base of the technology-related coursework is the notion of systematic application of technology in the teaching and learning process (Reiser & Radford, 1990). Pre-service teachers follow a systematic process as they analyze, design, develop, implement, and evaluate instructional products. An electronic planning tool, the Lesson Architect, is employed as a guide to assist pre-service teachers in creating technology-rich, integrated lessons and units that are aligned to student performance standards (Northrup, Rasmussen, & Pilcher, 1998; STEPS, 1998).

The Lesson Architect is a tool in the electronic performance support system, STEPS (Support for Teachers Enhancing Performance in Schools), that teachers can use for instructional planning. It follows Gagne's events of instruction (Gagne, Briggs, & Wager, 1992) and includes elements of a variety of curriculum models (e.g., project-based learning, problem-based learning, and thematic learning) (Northrup, Rasmussen, & Pilcher, in press). Pre-service teachers use the Lesson Architect as a tool to help them design and develop lessons. Within STEPS, model lessons, web sites, best practice databases, and tutorials are also available to pre-service teachers as needed.

Pre-service teachers complete a 120-credit hours of coursework, a typical Florida baccalaureate program. UWF is a regional institution in the panhandle of Florida; students range from the traditional 18-24 year old to non-traditional students who are returning to school or changing careers. The foundational philosophy of the College of Education (COE) program is one of the Empowered Person and Professional who has the skills of critical thinker, problem solver, lifelong learner, counselor/therapist, decision-maker, and ethical/moral being (UWF, 1998).

Support and Laboratory Facilities

Pre-service teachers have access to two computer laboratories, a Macintosh-based teaching lab and an open-access personal computer-based lab. All machines have Internet access. The Macintosh Lab has 32 multimedia stations, networked printer support, and a laser-disc player. The open access PC Lab has 15 multimedia, Pentium II machines and a networked laser printer. Both laboratories have various software packages including ClarisWorks, Office 98, and HyperStudio, in addition to a large number of CD-ROMs, provided by a Microsoft Teacher Training Grant. Labs are staffed by lab assistants who are available to assist students with their projects. Two full-time undergraduate faculty support the pre-service teacher technology classes with assistance from expert adjuncts, who, themselves, are classroom teachers with extensive experience in integrating technology into the classroom.

Technology Sequence

Before the current modifications to the technology sequence, pre-service teachers completed one, three-credit hour course on Instructional Technology (each credit hour equates to 12-16 hours of in-class instruction). In that course, they developed skills in productivity tools, multimedia use, and telecommunications; examined how technology was used in educational environments; and created sample technology-rich lessons. The technology component of the pre-service education program was modified to six credit hours of coursework:

1. EME 2040: Introduction to Educational Technology (3 semester hours)
2. Practicum II: Multimedia (1 semester hour)
3. Practicum III: Telecommunications (1 semester hour)
4. EME 3410: Integrating Technology Across the Curriculum (1 semester hour)

Throughout the technology sequence, pre-service teachers are provided with positive technology-use models (e.g., professors, supervising teachers, and field placement), given extensive opportunities to use technology, and, finally, they implement lessons using skills that they have learned. An integral part of the technology experience is the pre-service teachers' active reflection upon what they have learned and observed. The sequence begins in the sophomore year, continuing into the junior year. Courses are completed in the sequence listed.

Introduction to Educational Technology

In the introductory class, pre-service teachers (approximately 125 each term) develop and demonstrate basic skills in productivity tools (e.g., word processing, spreadsheets, databases, e-mail, and desktop publishing). They are introduced to uses of traditional media and multimedia and telecommunications concepts. As skills are developed, pre-service teachers also explore how technology can be used in various educational environments. Projects for this course include extensive portfolios that demonstrate proficiency in each of the targeted areas; performance-based and knowledge-based tests are also completed. Individual classes are comprised of both lecture (in a traditional classroom, with projection system) and laboratory experiences, with the primary focus being on development of skills in the laboratory. Pre-service teachers have access to both Macintosh and Personal Computer-based systems in two different labs and are expected to spend at least two additional hours per classweek working on assignments outside of class. With this foundation, students are prepared to develop additional skills in multimedia telecommunications in their practicum experiences.

Practicum Courses

To introduce pre-service teachers to how technology is used in the classroom, strong technology components are required in two of four required practica. Each practicum consists of students observing and working in a PK-12 classroom. For each technology field experience, practicum students are matched to teachers and schools who have access to appropriate technologies. In Practicum I, pre-service teachers observe classroom management techniques, student-teacher interaction, and the day-to-day operations of a classroom. In Practicum II, multimedia is the primary focus; Practicum III has an added telecommunications component. In Practicum IV, pre-service teachers are closely supervised as they approach their student teaching experience. At the successful completion of Practicum IV. they enter the student teaching experience. For each technology-based practicum, students spend 80 hours in the field, in an assigned classroom, and 20 hours developing multimedia or telecommunication rich lessons, which they then present to their PK-12 students. After the in-field experience, practicum students return to the college classroom to reflect on the outcomes and present their experiences to faculty and their peers.

Multimedia Practicum. This technology experience is comprised of five sessions in addition to development and implementation activities. The sessions are four hours each and are held over the entire semester. In the multimedia practicum, the students explore various types of multimedia such as CD-ROMS, laserdiscs, digital photography, and authoring systems. In the first sessions, students are introduced to systematically designing instruction using a generic instructional design model, the ADDIE model (Gagne & Medsker, 1996) where they focus on how the analysis, design, c/evelopment, implementation, and evaluation of the instruction matches the lesson that they will create (see Table 2). They also complete simple storyboarding/screen design tasks. Students collaborate to design a simple HyperStudio stack, assisting each other in the development process. This sample stack includes animation, scanned graphics, QuickTime movies, text boxes, test questions and buttons so that basic multimedia skills are acquired. To facilitate design and development, the instructor provides an instructional goal; practicum students develop the content that meets the goal and associated storyboards that match the learner and content analysis. At the end of the session, practicum students are instructed to contact their supervising teacher and instructional technology personnel to determine what multimedia resources are available at the school site. They also begin to plan their technology -integrated lesson, associated content, and storyboards. Students are encouraged to use the Lesson Architect to assist them in their design activities.

At the second session, the students create their lesson, including a HyperStudio stack. Appropriate multimedia elements are included in their project (e.g., graphics, digital pictures, etc.). Students consult with technology faculty and other students at this time to ensure high quality materials. At the end of this session, the lesson is ready to be implemented back in the classroom. An evaluation rubric is provided so that the lesson can be evaluated upon completion in the classroom (see Table 3). During the third session, the students work with the digital camera, CD-ROMs, and laserdiscs to explore how multimedia elements can be used in classrooms.

Table 1. Pre-Professional Accomplished Practices and Student Activities.

Sample Indicators (Florida Technology Accomplished Practices)	Pre-Professional Requirements	Sample Activities	Technology Class(es)
Utilizes appropriate learning media, computer applications, and other technology to address students' needs and learning objectives	Uses, on a personal basis, learning media, computer applications, and other technology	Use productivity tools for class projects (word processing, spreadsheets, database, desktop publishing, presentations)	EME 2040 EME 3410 Practicum II Practicum III
Utilizes instructional and other electronic networks to provide students with opportunities to gather and share information with others	Utilizes instructional and other electronic networks to gather information	Join class listservs, research the WWW for lesson plans, and educationally-related information	EME 2040 Practicum III
Utilizes a wide range of instructional interactive video, audiotaping, and electronic libraries to enhance the subject matter and assure that it is comprehensible to all students.	Can identify and use standard	F,valuate CD-ROMs, inclusion into classroom activities	Practicum II
Continually reviews and evaluates educational software to determine its appropriateness for instruction and management and compare findings with others	Selects and utilizes educational software for instruction and management purposes based on reviews and recommendation of other professionals	Review instructional software for alignment with stated objectives	EME 34 10
Teaches students to use available computers and other forms of technology at the skill level appropriate to enable success and maintain interest	'leaches students to use available computers and other forms ol technology	Develop technology-rich lessons and implement in field experiences	Practicum II Practicum III
Uses appropriate technology to construct teaching materials, e.g., construct assessment exercises, prepares programmed instruction, uses word processing, produces graphic materials, etc.	Uses technology in lesson and material preparation	Create handouts, lessons, and tests using appropriate technologies	EME 2040 EME 3410 Practicum II Practicum 111
Uses appropriate technologies to create and maintain databases for monitoring student attendance, behavior, and progress toward specified performance standards	Uses technology to assist with instructional and classroom management	Develop database to assist in classroom management activities (e.g., grade rolls, class rosters, inventories)	EME 2040
Provides instruction at the appropriate level in identifying and using standard references, other learning resources, gathering data and anecdotal information and accessing computer data banks	Can identify and use standard references in electronic form	Research using CD-ROM, WWW. and library resources	EME 3410
Works with technical and instructional specialists available to the school, teachers, and students to collaborate on instructional design and delivery	Works with on-site technical and instructional technology specialist^) to obtain assistance for instructional delivery	Works with field experience supervisors to implement technology lessons	Practicum II Practicum III
Develop short and long-term persona] and professional goals relation to technology integration	Develops short-term personal and professional goals relating to technology integration	Discusses and develops professional development plan, especially related to enhancing technology skills	EME 3410

Table 2: Multimedia Practicum Session 1.

Instructional Design	HyperStudio Activities	After the Session
ADDIE Model, including: Learner Analysis Task Analysis Environmental Analysis Storyhoarding Screen Design Implementation Constraints Evaluation Requirements	Stack Creation, including: Buttons Text Boxes Graphics Animation QuickTime Movies Sound	At Practicum School: Locate HyperStudio Determine Platform OnOwn: Plan Lesson Create Stor\boards Gather Graphics

To prepare for their final assignment, practicum students create presentations using PowerPoint in the fourth session. Screen design, transitions, builds, and inclusion of multimedia elements are explored to design a presentation that describes learning environment and the lesson implementation. At the final session, students present their work, using projection devices, to faculty and other pre-service teachers, reflecting on their practicum experiences.

Telecommunications Practicum. In Practicum III, educational telecommunications applications are explored. To model telecommunications delivery and use, the practicum is presented via the World Wide Web (WWW). Instructional activities include: surfing the WWW for lesson plans, contacting an experienced teacher via e-mail to find out how they use telecommunications, communicating 'and collaborating with other students using a listserv, and exploring instructional websites on the WWW. Following the structure of the multimedia practicum, students create a lesson incorporating telecommunications and implement it as part of their field experience. Again, they use the Lesson Architect template for lesson design. In conjunction with their telecommunications lesson, an instructional web page is designed, developed, implemented, and evaluated. At the end of the practicum, pre-service teachers present their work and reflect on their experiences.

A class web site is created that includes the instructional material, activities, and assignments created by the pre-service teachers. A sample web page is available so that practicum students can model, then create, their own web site. An example of a student's telecommunications lesson using the Lesson Architect is found in Table 4.

Integrating Technology Across the Curriculum

As a capstone experience, Integrating Technology Across the Curriculum is completed. In this course, pre-service teachers re-explore technologies and reflect upon how those technologies can be used to facilitate the teaching and learning process at a unit, rather than a lesson, level. In addition, topics such as resources that might be used in the classroom, ethical concerns of using technology, and how to teach with technology are explored. Personal experiences gained in the practicum enable the pre-service teacher to reflect upon practicalities and realities of how technology can be used in the classroom. The Accomplished Practices related to technology are reviewed, discussed, and personal skills are evaluated. Professional development plans are designed that focus on skill-deficient areas. Using skills acquired in the technology sequence, pre-service teachers develop portfolios and unit plans that showcase how technology can be integrated into the PK-12 classroom. These materials are designed to be used as reference materials when the pre-service teacher graduates to his/her own classroom.

Table 3. HyperStudio Lesson Evaluation.

Technical Aspects		
Do all the buttons work?		
Back	Exit	Next
Test Answer	Help	Menu
Do the QuickTime movies work[7]	Yes	No
Does the animation work?	Yes	No
Is the text accurate?	Yes	No
Is the spelling correct?	Yes	No
Aesthetic Aspects		
Are the colors appropriate?	Yes	No
Is the font/size appropriate?	Yes	No
Are multimedia elements relevant?	Yes	No
Is screen design consistent?	Yes	No
Instructional Aspects		
Were the students able to read the text?	Yes	No
Did they understand what they read?	Yes	No
Were students able to navigate the lesson on their own?	Yes	No
Were students successful in completing test items?	Yes	No
Did students speak positively about the program after completing it?	Yes	No

Conclusion

This program has been in place for approximately three academic terms. Results of this integration of technology are just beginning to be realized. Transfer of the knowledge and skill base in the Introduction to Educational Technology needs to be enhanced. Many students take the course very early in their academic career and may not receive the opportunity to practice all of the skills learned until they reach Practicum II. Consequently, there is a period of retraining that must take place in Practicum II. Faculty teaching other College of Education courses are continuing to increase activities using technology including requiring electronic presentations, developing class web pages, and using multimedia and telecommunications for class assignments. We anticipate that with increased uses of technology in other classes, this period of retraining will decrease. Other results observed include:

- entering practicum students are overwhelmed by the amount of available technology; however, once they begin to work with the technology, they become comfortable with it,
- practicum students report that PK-12 students enjoy the multimedia or telecommunications lessons and are motivated by them,
- practicum students need a framework and structure at the beginning of the sequence which can lead to increased freedom later, and
- practicum students are helping to bridge the gap between in-service training and technology integration in the classroom by assisting supervising in-service teachers in learning more about technology and integrating technology in the curriculum.

This model of training pre-service teachers prepares the student for success by offering them the opportunities to see technology integrated into the College of Education classroom, develop lessons and implement them, and finally, to reflect upon the uses of technology in the PK-12 environment. The benefits of this program have yet to be fully realized and evaluated. Determining the impact of this program is an important investigation that needs to be undertaken as a next step.

As we increase the technology-literate pre-service teacher population, they will be able to integrate technology in their field experiences, assist supervising teachers, and gain valuable real-world experience that they can use upon graduation. Using this model of integrating technology, students no longer are taught technology skills and integration in isolation. Rather, they develop basic, broad skills, then apply those skills in real world situations where they can try new ideas. When these future teachers walk into their new classroom, they will be ready to integrate technology effectively.

Table 4: Example of Pre-Service Teacher Lesson Using the Lesson Architect.

Q3K *Written by:* Jackie Adams

School: *C.A. Weis Elementary* District: *Escambia* Subject/Theme: *Reading and/or Study Strategy'*

Planning The Lesson

GOALS:

As a result of this lesson, the students should know/understand: a) that learning a pre-reading strategy will help to improve their grades; b) that authors use bold headings, charts, and graphics to help the reader better understand the meaning of the text: c) that listening carefully to a speaker shows respect, d) how to construct meaning from text; e) speaking strategies effectively.

Sunshine State Standards:

Language Arts-Reading-Standards 1 & 2 (LA.A.1.2& LA.A.2.2); Language-Standards I&2 (LA.D.1.2& LA.D.2.2); Listening, Viewing, & Speaking Standards 1 & 3 (LA.C.1.2 & LA.C.3.2): Goal 3 Standards-1,2,4,5,8.

OBJECTIVES: As a result of this lesson, the students should be able to:

a) explain many reasons why a pre-reading strategy can improve grades;

b) describe how bold headings, charts, and graphics are used to help the reader better understand the text;

c) demonstrate respect by listening to others when they are speaking:

d) explain the main idea from reading material:

e) speak clearly and use appropriate volume when working in a small group environment.

RESOURCES: To complete this lesson 1 will need: chart paper, marker, a couple different textbooks that has bold headings, charts and graphics (social studies and science), copy of a blank web for each student.

INTRODUCTION: To motivate the students into wanting to listen to the lesson. 1 will start out with the question, "How \vould you like to learn a way to read your textbooks and storybooks that would help you make better grades and make reading and understanding those books easier?" 1 will explain that if they learn the strategy I am about to teach them their grades will go up. textbooks will be easier to understand, and comprehension of material read will improve.

LESSON ACTIVITIES: I will start out by reminding the students to raise their hand before answering any questions. No one can learn anything if everyone is talking at one lime, and that it shows respect for others when one waits to speak. I will give a brief overview of the pre-reading strategy SQ3R. Next, with the help of the students we will create a web-graphic organizer outlining the different states of the strategy. For example, S stands for survey and in this stage students look at all the title and headings and quickly read the overview of the chapter and the summary. This gives the student an overall picture of what the chapter will be about. Q stands for question. In this stage, the student turns each heading into a question to create a purpose to read. The first R stands for read. In this section, the reader reads to answer the question created in the above stage. This provides the reader with a focus. The second R stands for recite. In this stage, the student test oneself by answering the question that has been created. The last R stands for review. In this stage, the student reviews the reading assignment which helps put the information all together and helps comprehension. After going over this information, the students will e-mail college students who have started using this strategy since learning it and ask them questions about the strategy. Students will also visit the web page I have designed as a review of the strategy. The web page will be available for any student wanting to review the strategy. During all of the stages I will model it by using the students' science and social studies book. I will bring to a close the lesson by stressing how after learning this strategy my grades greatly improved.

ASSESSMENT: First, as I present the information, I will observe the students for understanding or misunderstanding of the information being taught. 1 will question any student who may look confused to be sure and straighten out any questions as they arise. 1 will question the students at random to assess the group as a whole.

LEARNING ENV IRONMENT

Instructional Strategies

Cooperative learning strategies, Reflective thinking strategies. Graphic organizer, strategies. Decision making strategies, Problem solving strategies

Innovative Methods

Mathematics, Language Arts. Science. Social Studies

Instructional Technology Approaches

Web-Based Instruction, Software Applications. Presentations. F.-Mail

Sl'.MMARY: To summarize the lesson. 1 will question the students informally. For example. I will call on a student to tell me what the S means in the strategy and what should be done during that stage. I will continue in this manner.

ASSESSING STl'DENT OITCOMES: To assess the students. I will informally question the students. This lesson is an ongoing type of lesson to be practiced over a long period of lime. I will question students every time we start a new story in our reading book as to the proper strategy to use when starting new reading material. I will also observe the students when they start a new lesson on their own to see if they start with the S in the SQ3R strategy before reminding them of the proper strategy.

Assessment Strategies

Teacher-assessment, Peer-assessment

Assessment Tools

Informal assessments

References

AETT (1995). *Employability Skills for British Columbia.* Ministry of Advanced Education, Training, and Technology, [online] Available: gotobbutton bm_4_http://www.aett.gov.bc.ca/employability/.

Braun, L. Moursund, D. & Zinn, K. (1992). *Vision: Test (Technology Enriched Schools of Tomorrow.)* [online] Available: gotobutton bin_3_http://www. Iste.org/.

Florida Education Standards Commission (1996). *Accomplished, Professional, and F're-professional Competencies for Teachers of the Twenty-First Century.* Tallahassee, FL: Florida Department of Education.

Florida Department of Education (1996). *Florida Sunshine Slate Standards.* Tallahassee, FL: Florida Department of Education.

International Society for Technology in Education (1998/ *National standards for technology in teacher preparation,* [online] Available: gotobutton bm_ 5_http://www.iste.org/.

Gagne, R.M., Briggs, L.J., & Wager, W.W. (1992). *Principles of instructional design.* Orlando, FE: Harcourt Brace Jovanovich College Publishers.

Gagne, R.M. & Medsker, K..E. (1996). *The Conditions of Learning: Training Applications.* Orlando, FE: Harcourt Brace Jovanovich College Publishers.

Northrup, P.T. & Eittle, W. (1996). Establishing instructional technology benchmarks for teacher preparation programs. *Journal of Teacher Education ,47(3), 2 * 3-222.

Northrup, P., Rasmussen, K. & Pilcher, J. (1998, February/ *The lesson architect: A template for designing technology-rich classroom instruction.* Paper presented at the annual meeting of the Association for Educational Communications and Technology, St. Louis, MO.

Northrup, P.T, Rasmussen, K.L.. & Pilcher, J.K.. (in press). STEPS: An EPSS Professional Development Tool. In B.I1. Kahn (ed.) *Web-Based Training.* Englewood Cliffs, N.J: Educational Technology Publications.

Peck, K.E. (1998). Ready ... Fire ... Aim! *Toward meaningful technology standards for educators and students. TechTrends, 43(2).* 47-53.

Reiser, R.A. & Radford, J.A. (1990). Preparing pre-service teachers to use the systems approach. *Performance Improvement Quarterly, 3(4),* 40-52.

The Secretary's Commission on Achieving Necessary Skills (1991, June), [onliney *What Work Requires of Schools: A SCANS Report for America 2000.* U.S. Department of Labor. Available: http://www.ttrc.doleta.gov/SCANS/.

STEPS (Support for Teachers Enhancing Performance in Schools) (1998). [online] Available: gotobutton bm_6_http://scholar.coe.uwfedu/pacee/steps.

U.S. Congress. Office of Technology Assessment (1995). *Teachers & Technology: Making the Connection.* Washington, DC: U.S. Government Printing Office.

UWF NCATE Documentation (1998). Conceptual Framework. UWF: Pensacola, FL.

<u>*Authors*</u>

Karen L. Rasmussen is an Assistant Professor and Coordinator of Instructional Technology at the University of West Florida.

Sue Norman is a Research Associate at the University of West Florida.

Book Reviews

Orchestrating multimedia: *An introduction to planning and storyboarding educational multimedia.* 1998, by Marilyn Welsh. ON: Irwin Publishing, 165 pages. ISBN 0-7725-2462-9. Accompanying CD-ROM.

Review by Katy Campbell

Marilyn Welsh is the Director of the Centre for Educational Effectiveness at Seneca College of Applied Arts & Technology in Ontario and, as such, has worked with teachers, faculty, trainers and developers to design instructional multimedia. Her roots in teaching, performing, and managing are evident in this practical guide to instructional development.

Orchestrating multimedia is a clear and comprehensive guide to the complex process of multimedia development, unique in that it is aimed at the educators who are, increasingly, finding themselves responsible for or involved in these projects. This target audience finds themselves, as subject matter experts with no formal training in technology-based teaching and learning, expected to not only adapt and effectively implement technology approaches in their classrooms, but to design, produce, and (hopefully) evaluate multimedia products as a matter of course in their institutions. This book and accompanying CD-ROM are a nicely designed and executed response to the needs of this group.

The book, written to reflect a systems approach to designing instruction, is a linear, phased approach to a multimedia project, taking the reader from needs assessment, through task analysis, defining roles, managing the process, writing a proposal, developing objectives, structuring the material, and flowcharting and storyboarding. The underlying assumption, that most multimedia projects will be realized by a production team or assistants is possibly flawed, depending on the institution and/or complexity of the product. Welsh takes a creative and idiosyncratic approach to the sequencing of steps in a systems ID model, but it seems to make sense in this carefully-defined context. Actually, those of us in instructional design can confirm that the process is very organic and reflective of the needs of the team members, institutional culture, and instructional requirements and content, although generally one should not specify tools before defining outcomes.

Each of the three main chapters refers to the interactive CD-ROM, which contains examples, and exercises. The author's intent was to present faculty-designed products as examples of achievable materials, and the excerpts chosen reflect this.

The book contains reproducible worksheets and forms for each step in the development process, as well as appendices that explore learning style differences, copyright issues, and multimedia terms. Although none of the appendices cover the theoretical or legislative bases of these issues in any detail, including them raises awareness and points readers to additional resources and references.

This package will appeal to developers such as have been described precisely because it permits them to "roll up their sleeves" without burdening them with the philosophical or theoretical underpinnings of learning theory and instructional design. Nevertheless, well-supported applied research provides the basis for suggestions and tips that accompany each chapter. This is an eminently usable resource and could justifiably be given to each faculty member as a good introduction, or review, of the course development process for either teacher-directed or distributed learning environments.

Reviewer

Dr. Katy Campbell is an Assistant Professor and Instructional Designer with Academic Technologies for Learning, University of Alberta.

Research In Distance Education *4,* edited by Terry Evans, Viktor Jakupec and Diane Thompson. Revised papers from the fourth Research in Distance Education conference, (Deakin University 1996), Geelong: Deakin University Press, 1997.
ISBN: 0-9498-2367-8, 255 pp.

Reviewed by Rafael Cota Rivas

I was expecting something else from this book, something sophisticated and somehow cryptic for the majority of people, but I was mistaken. The book is simple enough to understand, and even better, it triggers your motivation to ask yourself questions about the different topics and techniques described in all of the chapters. It's the kind of book that makes you wonder about the things beyond your daily work, back to things that you have already forgotten and forward to things that you didn't know were there.

This book is a compendium, the fourth actually, of papers from the Reasearch in Distance Education (RIDE) conference held at Deakin University in December 1996. The work includes a total of 19 chapters from numerous different authors. Each paper is related to distance education, and, in most of the cases, to the research in the distance and open education.

The first chapter is written by the editors, Terry Evans, Viktor Jakupec and Diane Thompson. They have done very good work, not only in selecting the papers, but also in the organization and arrangement of them. The book can be read without a particular order, but if you prefer to read it sequentially, you will find out that there is a logic to the order to the papers and the editors decision to lay the book out in this manner.

The papers found in the book include several topics and/or areas of research in distance education from many parts of the world, a fact that makes this book very interesting in my opinion. Several chapters discuss educational research itself and the questions that have to be answered when conducting research in distance education. Other chapters are examine some of the approaches in assessing open and distance learners. For me, the most interesting chapter was Chapter 13 by Elizabeth Stacey, who covered issues about collaborative learning at a distance.

The book is substantial, containing 255 pages with 18 pages devoted to the many (over 380) references listed in the book. The reference section would be very valuable for the novice researcher, as a listing of many of'the' important writers in the field of distance education.

If you are looking for a book that can help you build and develop a distance education program with simple guidelines and useful examples, then this book is not going to help you. There are many other 'how to' books written in the field.

This compendium will, instead, give you a pretty good look at the research that is taking place right now in the world of distance and open education. A must have for anyone wanting to examine current thoughts in the field.

I really enjoyed this book and feel it would be very useful for a professional or researcher in the distance and/or open education. Many of the chapters can be used as a reference for future research and, one hopes that this work will be added to, creating the appearance of future papers to be presented in conferences.

Reviewer

Rafael Cota Rivas is an instructional developer/project manager in educational technology at ITESM Campus Sonora Norte in Hermosillo, Mexico. He is presently working on his Masters Degree in Educational Technology.

Microware Review

L.F. (Len) Proctor, Editor

The Digital Field Trip to the Wetlands by Digital Frog International, Trillium Place, RR#2, Puslinch, Ontario, NOB 2JO
This review is reprinted from The Canadian Journal of Education Communication, Vol.26, No. 3, because ofan error inprinting. Our apologies to Digital Frog International.

Reviewed by Dell Franklin

The Digital Field Trip to the Wetlands is the first in a series of "field trips" produced by Digital Frog International. The virtual tour of a bog environment is the flagship portion of the program with four other major topics that would be of interest to a young ecology students.

The package contains the program on compact disk, an instructor's guide and a student's guide. The instructor's guide is a brief introduction to the values and uses of the package followed by a copy of the student's guide with answers. The learning objectives are clearly delineated in the instructor's guide and the student's guide. The student's guide also contains a brief introduction to the workbook and a series of questions providing guidance on how to use the CD. This section is followed by a series of lists, rules and questions (with answers) which are generic enough to be used on any field trip to a wetland area but which can also be used to explore the CD. Lastly, a set of study questions are provided to reinforce the material found on the CD.

This package has been designed for a grade 10 age group. The ecological approach is appropriate for study units in chemistry, biology, geography and environmental science. As suggested by the teacher's manual, this program could even be used as a supplement to a language arts program because the text in the glossary is reinforced by a digital sound pronunciation of the word.

Unfortunately the attempts at humor in the student's guide border on the sarcastic. For example, the equipment list for real field trips contains the phrase: "Knapsack (unless you have more than two hands)"(p.2). This style detracts from the more meaningful examples regarding mosquito repellent, floatation devices and pens.

The Study ofa Bog

This section of the program contains three major foci: Formation and Succession, The Bog Food Web, and Adaptations in a Bog. Each of these are separate and the learner is free to choose the order and pace to proceed.

The Formation and Succession of Bogs is a tutorial that has two animated segments describing glacial formation and formation by beaver ponds. These contain higher order concepts involving geological time lines and are very clear and concise.

The immense span of time is functionally handled by the animation format and is reinforced by a moving time line along the bottom of the screen. These animations will play continuously or increased learner control takes place with the option of sliding the time line. A negative feature of the animations is the duplicity which takes place as the text is read to the learner. An increased form of learner control could be where the learner hears a different content line and/or has the option to turn the sound off.

The Bog Food Web is definitely the largest content area of the section The Study of a Bog and is also the most interactive of the three. While the five tutorials: Food Chains, Food Web Energy, Producers, Consumers and Decomposers are all linear with text reinforced by graphics of each concept, the species examples used are hyperlinked to the organism screens. The organism screens are similarly available from various other sections of the program and provide the learner with a wide variety of examples of species found within wetland areas. The Bog Food Web section also contains the Bog Food Web Game where the ecological concept of food webs and food chains are reinforced by linking consumers with food sources. In this screen, the learner may also hyperlink to the organism screens of each species in the game. Only correct links are allowed and the user can check the accuracy of their web at any time, receiving a number of correct links out of a total number of links. Furthermore, the score screen allows the user to view the total correct links highlighted, the links they had correct as well as the links by species.

In Adaptations in a Bog, there are two main sections. The section Adaptations in Animals has interesting examples of bird species and their adaptations to the winter environment. The learner interacts here by having to choose which birds do not migrate and select, on a different screen, where their food source may be located. This is an effective, however there are a large portion of adaptations among different species which are ignored, for example amphibian breathing in water environments. While it would be unreasonable to expect examples of all species in a wetland, the instructional design should have allowed for animals and insects to be shown rather than birds alone. The second section, Adaptations in Plants, also has interesting examples of interaction however there are few previous cues which would help a learner select how bog plants assimilate nitrogen from their environment. Again, textual feedback is used for incorrect answers with a game format used on a different screen showing the actual method the plants have adapted. Once again, the two specific types of plants used are an inadequate sample of the wide range of plant adaptations within a bog environment.

Wetland Types

This section has a variation on the graphical interface used. It begins with a split screen with four examples of wetland types shown and a description box in the middle. In the box is the options of playing the Wetland Types Game or viewing Other Classification Names for wetlands. By clicking on a photograph of a type of wetlands, the user is shown a diagram and photographic example for each type. This is the extent of the examples except for the peat lands example, which the designers break up into fens and bogs. This choice was content based as these two types are shown to have distinct similarities with an interactive comparison utilized. This interaction takes place via a split screen of the two types and if the learner clicks on an element in either photograph the program provides either a text or graph explaining the differences.

In the game the learner is shown photographs of various wetlands and then clicks on the multiple choice area. This area uses the metaphor of a remote control unit (RCU) and on this unit feedback is shown by several methods. A continuous score is shown on the RCU and if the learner is correct on the first try a higher score is given than on subsequent tries. Four tries are allowed with decreasing scores for each attempt and hints for each attempt are supplied.

Mechanisms of a Wetland

This portion of the program has the least amount of interaction for the learner. The more abstract concepts of Nutrient Cycles, Groundwater, Productivity, Wetlands, and Erosion and flooding are explained through text and, for the last three, some animation which the learner controls through buttons. The interface is consistent with the rest of the package.

Our Endangered Wetlands

This segment of the program web contains the sections Migration, Wetlands as Habitat, Conservation, and Pollution. The navigation scheme of the majority of the program is similar here with the initial screen showing the jigsaw sections. The migration focuses on birds and the initial screen is a text introduction with the example species graphically listed below. By clicking on the bird the learner, sees a set of folders with pictures, maps, and possible movies of that species. On that screen is also hyperlinked text describing habitat, behavior, range, food source, and migration. Also listed are the size and Latin name, the latter having a popup showing the taxonomy of that species.

The Wetlands as Habitat has a couple of unique features. While it shares the same appearance as Conservation and Pollution, it's text is first person with the species addressing the learner. The learner also has the option to hear the species read the text to them in a variety of voices, both male and female. The content of this section is presented as a series of species giving their reasons for the conservation of wetlands.

The Conservation area provides the learner yet another variation on control as each graphic example allows the learner to choose between text answers to three questions: "What is it?", "What effect does it have?", and "What can we do?". These questions are referring to the various elements of human activity that affect wetland conservation. Pollution provides the learner with the least interaction as there are no responses required. The examples of sources of pollution are reinforced by pop-up text.

The Field Trip

The virtual Field Trip to the Bog has some of the most interesting characteristics of the program. Upon clicking that piece of the jig-saw you are given the option of seeing where the bog is located. This geographic exercise requires the learner to find North America, Canada, Ontario and Algonquin Park, in order, before seeing an aerial view of Cloud Lake. Once their you begin your trip by seeing a three dimensional map of the area, a set of field notes (text in a graphical binder), and a small screen. On the screen the learner views a QuickTime video which allows the control and navigation. The learner can navigate to several markers within the movie, which are also shown on the map. At each marker, a set of notes and names of species which are hyperlinked to organism screens. The learner may also zoom in and out to view specific areas of the screen as well as have the view pan in any direction. This allows the learner the unique perspective of seeing where she/he has been. This is truly an example of a virtual experience.

The instructor's guide states "the Field Trip to the Bog is an excellent opportunity to synthesize knowledge by making observations and by analyzing those observations" (p.3). Making observations could be greatly enhanced if the screen display were larger and perhaps having the map as an option. Also the compression ratios on the graphics are not enough to allow for much enlargement. With the option to zoom in on objects, one would assume that the objects would not pixellate readily yet very little viewable enlargement is available.

Conclusion

The Digital Field Trip to The Wetlands is an interesting ecological package which is highlighted by a virtual field trip to a bog environment. This package utilizes a wide variety of interactive strategies to maintain attention and promote engagement with the learner. A few flaws in navigational strategy exist primarily due to the misguided assumption that student's always read the textual material supplied.

The content of this program is extensive, however some topics have been omitted or edited out. For example, the programmers chose to ignore a wide variety of wetland species when discussing adaptations and this would not go unnoticed by the experienced student and may lead to misconceptions by the novice. Many content areas have detailed textual accounts and highly intetractive learning strategies while other areas leave the impression that production deadlines may have caused these areas to be compiled in a hurry.

Not withstanding these drawbacks this software package provides a unique learning experience for young people concerned with the environment. Many people do not have the economic or geographic ability to visit wetland areas and The Digital Field Trip to The Wetlands uses the latest technologies of computer based instruction to give a very realistic account of the wetlands experience.

Recommended System Requirements

The hardware/software requirements are clearly labeled on the materials accompanying the CD. Basic requirements are:

PC version- a 386X/25 or better, 8 MB RAM, CD-ROM drive, Windows 3.1, VGA/SVGA displayin- 640x480 256 colors, with a sound card recommended.

Macintosh - LCII or better (16MHz 68030 machine), 5 MB RAM, CD-ROM drive, System 7, screen capable of displaying 640x480 256 colors.

Microware Reviewer

Dell Franklin is a graduate student in the Department of Curriculum Studies (Education Communications) in the College of Education at the University of Saskatchewan, Saskatoon, SK.

Information for Authors

CJEC welcomes papers on all aspects of educational technology and communication. Topics include, but are not limited to: media and computer applications in education, learning resource centres, communication and instruction theory, instructional design, simulation, gaming and other aspects of the use of technology in the learning process. These may take the form of reviews of literature, descriptions of approaches or procedures, descriptions of new applications, theoretical discussions and reports of research. Manuscripts may be submitted either in English or in French.

Manuscript Categories

Manuscripts may fall into one of two classes: General, dealing with a topic or issue at a general level (although reference to specific instances or examples may be included), and Profiles, dealing with or describing only a specific instance of an approach, technique, program, project, etc. A Profile may be thought of as a descriptive case study. Most manuscripts dealing with a topic in general should include reference to supportive literature, while manuscripts submitted to the Profile category may or may not make such reference. The Editor reserves the right to change the designation of a manuscript or to make a designation, if none has been made previously by the author. Authors interested in determining the suitability of materials should consult past issues of CJEC or contact the Editor. All manuscripts received by the Editor (either general or profile) will be judged for suitability, contribution, accuracy, etc. by a panel of anonymous reviewers designated at the time of submission. Normally, the review process requires about eight weeks. There are no deadlines for the submission of manuscripts.

Manuscript Preparation

Manuscripts should be printed on 8'/2 x 11 inch ordinary white paper. All materials must be double-spaced, including quotations and references, include a title page on which appears the title of the manuscript, the full name of the author(s) along with position and institutional affiliation, mailing address, e-mail address, and telephone number of the contact author. An abstract of 75-150 words should be placed on a separate sheet following the title page. While the title should appear at the top of the first manuscript page, no reference to the author(s) should appear there or any other place in the manuscript. Elements of style, including headings, tables, figures and references should be prepared according to the Publication Manual of the American Psychological Association 4* Edition, 1994. Figures must be camera ready if not in electronic form.

Submission of Manuscripts

Send four copies of the manuscript to the Editor along with a letter stating that the manuscript is original material that has not been published and is not currently being considered for publication elsewhere. If the manuscript contains copyright materials, the author should note this in the cover letter and indicate when letters of permission will be forwarded to the Editor. Manuscripts and editorial correspondence should be sent to: David A. Mappin, Canadian Journal of Educational Communication, Faculty of Education, Edmonton, Alberta, T6G 2G5. E-mail: David.Mappin@ualberta.ca