Preservice Teachers' Electronic Portfolios:
Integrating Technology, Self-Assessment, and Reflection

By Marilyn McKinney

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Situated within the context of efforts to transform schools and teacher preparation programs, both technology and portfolio assessment offer much potential as tools. Teacher educators have found that well-constructed portfolios may help to capture the complexities of learning, teaching, and learning to teach when used as authentic assessment tools within courses and programs in Colleges of Education (Carroll, Potthoff, & Huber, 1996; Hansen, 1996; Krause, 1996; McLaughlin & Vogt, 1996; Stahle & Mitchell, 1993; McKinney, Perkins & Jones, 1995; Ohlhausen & Ford, 1992). Kenneth Wolf (1991) suggests that portfolios "make it possible to document the unfolding of both teaching and learning over time" (p. 129). Portfolios may foster an inquiry approach and help shift ownership and responsibility of learning to the learner (Graves & Sunstein,

1992). In addition, they promote a reflective stance during which preservice teachers may be engaged in "revisiting and revising their ideas over time" (Wade & Yarbrough, 1996). Such a reflective stance allows the learner to not only step back from experiences but also to form connective links, to rethink past experiences in the context of new ones, and ideally to develop ways of applying those insights to future endeavors. Finally, consistent with a constructivist framework in which learners construct new meaning in terms of what they already know, students who create their own portfolios in teacher preparation programs may be more receptive to implementing them once they enter the K-12 arena.

Likewise, the thoughtful integration of technology into both teacher preparation programs and school settings offers much potential. In particular, hypermedia provides opportunities to seek out and form connections in dynamic, nonconventional, and learner-controlled ways. According to a recent federal report (U.S. Congress, 1995), in order to effectively use technology, "teachers need visions of the technologies' potential, opportunities to apply them, training and just-in-time support, and time to experiment" (p. 1). Recent reports of surveys of first-year teachers suggest that many of these teachers feel inadequately prepared to use technology once they enter the classroom (Strudler, Quinn, McKinney, & Jones, 1995; Topp, Thompson, & Schmidt, 1994; U.S. Congress, 1995). A 1995 national survey of recent graduates with an average of 2.8 years of teaching experience found that over 50 percent felt unprepared or poorly prepared to teach with information technology (Colon, Willis, Willis, & Austin, 1995). Colleges of education, then, have the responsibility to provide opportunities and support at both the graduate and preservice levels for teachers to participate in technology-rich classes and other field-based experiences.

While the potential of portfolios and technology is great, successful integration of just one of these tools into educational settings invokes a host of well-documented impediments. Together, the "shared potential" of hypermedia technology and portfolio self-assessment presents an even greater challenge to implementation. The challenge comes from several fronts: (a) lack of time—time to learn about both the mechanics and the potential, and time to experiment in supportive environments; (b) little support (both technical expertise as well as support from peers and administrative structures); and (c) limited and always changing resources—materials, software, hardware, funding.

In examining environments that may be conducive to experimentation and change, Seymour B. Sarason (1996) and others (Fullan, 1991; Fullan & Hargreaves, 1992; Rudduck, 1992) have written extensively about the importance of the culture in which change efforts are attempted. Michael Fullan's and Andy Hargreaves' (1992) framework for viewing teacher development and change suggests that both the culture of teaching and the real world context in which teachers work are central considerations. Clearly, the cultures of both the college of education in which a teacher preparation program is housed and the real world of the schools in which

preservice teachers learn to teach are important variables to consider when studying attempts to encourage the integration of technology and portfolios into teaching.

Building upon approximately six years of using self-assessment portfolios with undergraduates in literacy education classes, this article describes efforts to incorporate technology into the portfolio process through the creation of electronic portfolios. Specifically, it investigates the evolution of electronic portfolios over a two-semester period by preservice elementary teachers who were part of a cohort program. While there have been surveys conducted with teachers in their first years in the profession to ascertain their opinions of how well their teacher education programs prepared them to teach, including the ability to use technology, there has been little written about preservice teachers' perceptions during the process. This study addresses the perceptions of this population in relation to technology and portfolios and, more specifically, to electronic portfolios. The following questions have guided this study:

(a) What do teachers in an undergraduate elementary teacher preparation program see as important about the process of constructing their own self-assessment portfolios?
(b) What effect does incorporating technology have on the process of portfolio development?
(c) How does this change over time and with experience?
(d) What are the necessary support structures? and
(e) What are the impediments?

Background and Teacher Education Context

Currently, the elementary teacher preparation program at the University of Nevada, Las Vegas graduates approximately 200 students each year. Because of our location at the center of the fastest growing city in America, nearly all of those students are employed by the local school district, presently the tenth largest in the nation and hiring approximately 1,200 new teachers a year. The Collaborative Learning Instructional Methods Block (CLIMB) is an experimental cohort program in which undergraduate elementary education majors attend their classes together and work cooperatively with instructors, field supervisors, and teachers at two school sites in an effort to integrate methods coursework with field experiences and thus bridge the gap between university coursework and the real world of teachers.

At the time the CLIMB program was conceived, five major goals were established: (1) Helping preservice education majors recognize teaching as learning; (2) Promoting inquiry-based learning; (3) Developing reflective decision makers; (4) Developing an awareness of the special requirements of an increasingly diverse student population; and (5) Helping beginning teachers engage in collaborative dialogue with other professionals. In the fall of 1995, 27 students were admitted to the program, which involved a full-time commitment to complete five

concurrent classes during each of three semesters. Twenty-three have continued, completing student teaching during the Spring or Summer 1997 semesters.

In addition to the original goals established, faculty supported a strong technology thread which was woven throughout the program, in coursework and through the collaborative relationship established with the two school sites. During the first semester, students were enrolled in *Computers in Education* and began the process of integrating technology into coursework from other classes. For example, they created data bases of books they read for *Children's Literature*, and they included a technology component in the lessons they planned for an integrated team unit. They also began to use HyperStudio and e-mail. The second semester (Spring 1996), the *Literacy Methods* block was taught in the computer lab. As part of this course, students developed electronic portfolios in which they would show growth as learners and teachers in methods coursework and their field practicum for that semester. This paper describes the development of these portfolios and their extension into the following semester by five students. The technology component also involved teachers at both school sites who were enrolled in a graduate level multimedia class supported by an Eisenhower Grant (Strudler, Falba & McKinney, 1995).

Another focus of the program has been to help preservice teachers better understand issues related to assessment, including self-assessment and the integration of assessment with instruction. During the first semester, CLIMB students took *Tests and Measurements* as part of their block. For one integrated assignment, students developed and implemented an assessment component of the team unit, self-assessed their individual and team units, and peer-evaluated their teaching. They also had the option of developing a portfolio in their *Children's Literature* course, thus providing an initial experience with portfolio assessment which could be further developed with the electronic portfolios they constructed the next semester.

During the third semester of the CLIMB program, students were enrolled in methods courses for Mathematics, Science, Special Education, Reading Diagnosis, and their second Practicum. A major integrating focus during this semester prior to student teaching was looking closely at individual children. Students were given the option of continuing to develop the electronic portfolios from the previous semester or constructing a "paper" or "traditional" portfolio to demonstrate their growth and learning during the semester. Each student participated in a portfolio conference with her supervisor and one methods instructor from that semester.

Long-term partnerships with two elementary schools served to provide a supportive context for the use of technology and reflective practice, thus linking theory and practice. Together, the two schools provided opportunities for our students to work with children considered to be "at-risk," and in schools that supported multicultural perspectives, that provided models of effective collaboration, and that supported the integration of technology. In addition to the school sites, the College of Education has also supported technology and the development of innovative teacher education programs such as CLIMB. There has been a develop-

ing effort to build strong undergraduate and graduate technology programs, to provide support to faculty who wish to integrate technology into methods classes, and to assist faculty by allowing creative blocking of classes and use of the computer lab. For example, during the semester I was teaching the literacy methods block in the computer lab, we were able to rework the official schedule in order to have extended periods to work at the school sites and to develop the electronic portfolios. Technical support was provided by Christy Falba, a doctoral student in the department whose responsibility included working with faculty to help integrate technology.

Method

In order to more fully understand how five preservice teachers constructed and thought about the use of electronic self-assessment portfolios, multiple methods were employed in this study: portfolio analysis, survey, questionnaire, and focus group interview. In addition, each participant read the completed paper as a form of member checking. The use of several methods allowed for a richer and more fully developed description of these students' understanding and views, and it provided a way to triangulate the data, thus ensuring reliability and dependability of the study.

Informants

This study focuses on the portfolios and the views about portfolio assessment of five students who, when given the choice of constructing traditional portfolios or electronic ones as part of a requirement for the CLIMB program, chose to extend their work on electronic portfolios from the previous semester. Gina, Julie, Jolene, Patty, and Rhonda agreed to be informants for this study. In doing so, they consented to have their portfolios reviewed, and to complete the surveys and interviews. Each of these students chose to have her real name used in the paper.

Data Sources

Data sources included disk copies of the Spring and Fall 1996 electronic portfolios for each student, surveys related to experiences and beliefs about the use of technology in education, informant questionnaires, and transcriptions from a focus group interview with the five students who continued to develop their portfolios.

Portfolio analysis. Five sets of portfolios formed the basis for the portfolio analysis (Spring and Fall 1996 portfolios for each of the five informants of the study). These portfolios had been copied onto a zip disk following end-of-semester portfolio conferences with supervisors and course instructors. The five sets of portfolios were examined using the following categories as guides: organization, evidence of integration, evidence of reflection, evidence of growth in content knowledge from individual courses, evidence of focus on the individual child, changes between the first and second portfolio (design, capability with technology,

content, etc.). Two outside reviewers independently examined three of the five sets of portfolios and made comments related to the above categories, and I reviewed all five sets. One set of portfolios was reviewed by all three reviewers.

Surveys related to experiences and beliefs about the use of technology in education. A survey was administered to students in the CLIMB cohort during one class session. Twenty-one CLIMB students completed the survey; five of those students chose to complete an electronic portfolio the following semester and 16 completed non-electronic portfolios. This survey was one of two forms of a questionnaire adapted from the National Eisenhower Computer Questionnaire (Wetzel, Zambo, Buss & Arbaugh, 1996). One form was developed for use with CLIMB cooperating teachers enrolled in the Eisenhower Grant course described earlier, and the second form was adapted for the preservice CLIMB students.

Thirty-five of the questions asked students to respond to a 6-point Likert scale on which "1" represented "strongly disagree" and "6" represented "strongly agree." The first 15 questions solicited general information about familiarity of platform (Mac or IBM), frequency of use at home and at practicum sites, familiarity with applications, etc. The final question asked students to "...specify the types of help you need to complete CLIMB assignments/projects which involve technology." For the purposes of this paper, 21 items from the preservice survey which directly or indirectly related to the use of technology for portfolios were selected as a way of looking at differences between the five students who chose to continue the portfolios and the other 16 cohort students who completed the questionnaire but chose to develop paper portfolios. The items were clustered into the following categories: confidence, beliefs/attitudes about technology, responses to traditional impediments, and skills/expertise related to technology.

Informant questionnaire. The five informants provided written responses to six questions which revolved around the research questions for the study: (1) What do you, as a student in an undergraduate elementary teacher preparation program, see as important about the process of constructing your own self-assessment portfolio? (2) What effect does incorporating technology have on the process of portfolio development? (3) How have your views about portfolios and the inclusion of technology changed over time and with experience? (4) What do you see as the necessary support structures for developing electronic portfolios? (5) What do you see as impediments? A sixth question was added for the interview: (6) What do you see as the future of portfolios (and of electronic portfolios) in teacher preparation programs?

Transcriptions from focus group interview. A focus group interview with the five informants was scheduled for a Sunday afternoon in the computer lab. As part of their agreement to participate, the CLIMB students were promised computer time and assistance so that they could continue work on their portfolios. Because of a

number of constraints, most of the students were only at the very beginning stages of constructing their second portfolios, which may have influenced their thinking about the process. Although the six questions comprising the Informant Questionnaire (see above) were used as prompts for the focus group interview, students and interviewers felt free to elaborate, ask for clarification or change the direction of the conversation. Christy, the doctoral student who had been available to provide technology help throughout both semesters, and I were both present and actively participated in the discussion. The focus group interview was audiotaped and transcribed for analysis.

Findings

The findings of the study are reported below, organized into two major sections. The first section describes the analysis of the portfolios in order to provide an overview of the organizational categories, content, reflection, challenges associated with technology, and changes over time. The second section is developed around the five research questions. In that section, I have drawn from each of the data sources, although not all data sources were used to answer all questions.

Analysis of Portfolios

Organization. Table 1 displays the basic organizational categories selected by each of the students for Portfolio 1 and Portfolio 2. Although there were similarities in terms of the types of information each decided to include (*e.g.*, goals, philosophy, examples of lessons), it is also apparent that each student chose to display and organize her information in personally unique ways. Gina's and Jolene's categories were very similar, though each chose to discuss her insights and reflections in ways that made personal sense. Gina mentioned that she had originally hoped to continue her portfolio from the first semester with links to show changes and growth; she was thus disappointed to find that was impossible due to problems with disk space.

Rhonda's categories were perhaps the most unique in terms of category titles (*The Believer, The Learner, The Educator,* and *The Future*); she chose to use the same categories for both portfolios. It is important to note that she also considers herself an IBM user and had a great deal of difficulty with the Mac version of HyperStudio crashing each time she tried to make changes; she had to start over at least eight or nine times! However, within those same categories, she made significant changes to the content and the reflections in her second portfolio. Julie, another PC user, located an IBM version of HyperStudio for her second portfolio; unfortunately, by the time she finished, she felt it was more limiting than the Mac version. Thus, her changes in categories which changed from *Philosophy, Growth, Lessons, and The Future* to *Math, Special Education, Science and Reading* seem to reflect design features that related more easily to the IBM version. She still included a philosophy statement and examples of lessons; however, they were embedded

within the content categories.

Patty was considered by the group to have the most proficiency with technology. Her first portfolio included an interesting opening screen with "Twilight Zone" music and words announcing to viewers that they are about to enter "The Portfolio Zone." Viewers then move to a screen on which she uses the metaphor of a chick hatching to compare herself as an emerging teacher. In order to get around the space limitations, she attempted to include links to ClarisWorks files which did not always work. Her second portfolio incorporated some creative graphics in the opening two screens. The first was a sun rising behind a mountain range with the words,

Table 1
Overview of Portfolio Organization and Contents

	Portfolio 1 (Spring 1996)	**Portfolio 2 (Fall 1996)**
Gina	Goals (personal, professional) Philosophy Growth Summary	Growth (goals, lessons, philosophy) Reflections/insights (journal entries) Case study
Patty	In the classroom (Egypt, poetry units, practicum) Goals (personal, professional stress journal; changes) Philosophy	Case study Philosophy (graphic with 9 links) Goals (personal, professional) Practicum (lessons, reflections from both semesters) Final (overview; the future)
Rhonda	The believer (beginning-early beliefs; developing beliefs; evolving beliefs) The learner (LA; classroom; SS) The educator (learning climate; physical environment) The future	The believer (beliefs from beginning; evolving beliefs) The learner (integrating LA; Math/Sci; member of society) The educator (same categories) The future (same categories)
Jolene	Goals (personal, professional) Philosophy Lesson plans (links to lesson log) Growth	Goals (personal, professional; insights) Philosophy (LA, Rdg; Science; Math) Lessons (11 lesson overviews) Case Studies (2: background; strengths; weaknesses; recommendations)
Julie	Philosophy (1/96; 5/96; changes) Growth (through goals—personal and professional; through doing) Lessons (from Africa unit) Future	Math (learning; 5 lessons; philosophy) Special Education (learning) Science (question types; learning; 3 lessons) Reading (learning; Joe: attitude, vocal, same teacher; philosophy)

"Horizons of Change" across the top (See Figure 1). The second screen presented a sand-like background with a web of interlocking philosophies (See Figure 2); each linked to a list a statements that appear to align with professional organizations and/or content area coursework (See Figures 3 & 4).

Integration, growth in content knowledge. The portfolios were examined to look for evidence of integration of content as well as growth in content knowledge. The major way that integration was shown was through inclusion of examples and/or discussion about integrated, thematic units, and through reflective comments which were often accessed through button links or scrolling screens which focused on insights/reflections. Sometimes they referred to important insights that connected classes, such as Rhonda's comment: "It amazed me that the questions used as effective tools in Science were the same questions that represented good problem solving skills in Math."

Evidence of reflection. Second portfolios included fewer artifacts or examples of evidence and more general, reflective commentary. First portfolios often included actual lesson plans or excerpts from journal entries; a few included examples of children's work or photographs. The second portfolios seemed to focus more on stepping back, taking an even more reflective stance, and demonstrated a greater awareness that people viewing their portfolios might not have the patience or desire to see large quantities of text and multiple examples.

Focus on school-based experiences. There was a clear focus throughout each set of portfolios on the importance of working in schools as a way of shaping philosophies and building confidence as professional educators. Students also indicated clear connections between these experiences and the content of the methods coursework. For example, Jolene noted, "The courses I have taken have helped me to develop the necessary background to go out into the schools and test my ideas and beliefs." Most of the students mentioned a clearer understanding of "why" they were teaching particular lessons; this was a recurring theme throughout their methods coursework, but interestingly represented by several students in their second portfolios in relation to lessons learned from their mathematics methods course. Both Julie and Jolene included a screen with a blue background and the word "why?" written all over it in different sizes and fonts. Gina stated, "I feel that I now think more about why I am doing things. I need to find real reasons for teaching lessons and make sure the children know this as well."

There was also evidence of growth of confidence in their ability to help children learn; confidence was related to experiences from classes which had focused assignments on careful observation of individual children. As Gina noted, "I've also found that children can discover their own answers when the teacher uses proper questioning techniques. Children can often tell me the answers or find their own reasons for mysteries just by my asking a question that gets them thinking."

Rhonda summarized her change in philosophy in a humorous way: "In the beginning there was the I TEACHER You Student way to teach, then it was I facilitate you listen, NOW it is I ask...Student seeks."

Research Questions

What do preservice teachers see as important about the process of portfolio self-assessment? In their answers to the questionnaire items and during the focus group interview, the students expressed a variety of views about the importance of constructing self-assessment portfolios. In general, they found portfolios allowed them to be reflective, to demonstrate their growth to themselves and to others, to be in control of how to express that growth, and to help them see connections between classes as well as between classes and their field experiences.

The following comments are reflective of the group:

> Constructing my portfolio helps me cement my philosophy into something concrete. It provides a place for me to record my growth and progress and helps me to see the improvement I made over time.
>
> As a pre-professional I see the benefits of assembling my own portfolio as being a way to let others see how I developed and learned through a specific amount of time.
>
> The portfolio allows me to put in those things that I personally feel are important to my growth as a professional.

Rhonda specifically mentioned differences between portfolio assessment and traditional exams, "It boils down to: do you want to hear what the instructor and/or book said, or do you want to see how that knowledge was used, integrated, assimilated and user-learner assessed?"

What effect does incorporating technology have on the process of portfolio development? When asked to describe the effect of technology on the portfolio process, responses from the written questionnaire, the focus group interview and the survey portrayed a positive view while still maintaining an awareness of problematic issues. The favorable aspects of incorporating technology included: the nonlinear nature of multimedia software allowed them to more easily show connections, and technology supported the ability to personalize the way they showed their learning. In addition, some felt that using technology allowed them to be on "the cutting edge" because they would have electronic portfolios to use for interviewing and because they had a greater understanding of how to help children in their future classrooms develop multimedia portfolios and projects. For example, Jolene said, "This is something I would use in the classroom because I'm comfortable with it now. Before I probably really would have shied away from it."

Although they discussed problems associated with the software, mostly focusing on space limitations, they also saw this limitation as having a positive influence because it required them to be more selective in what they chose to include

Figure 1

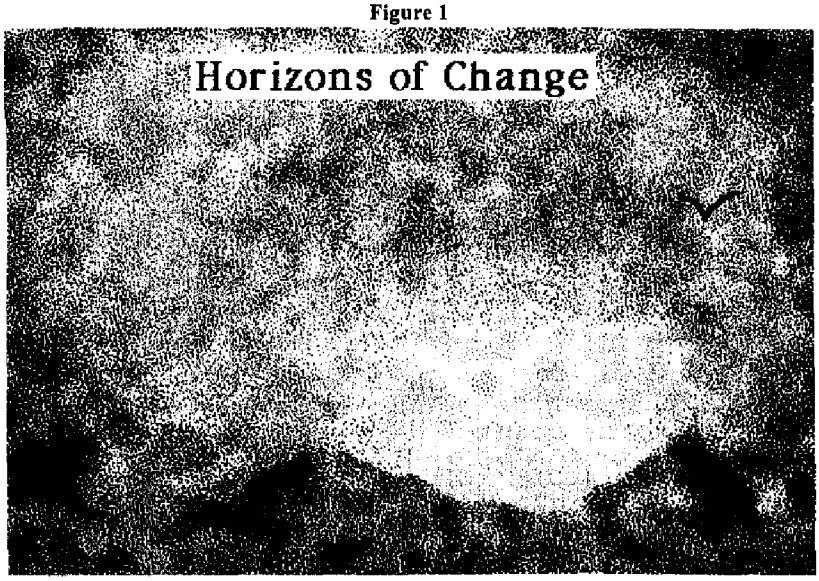
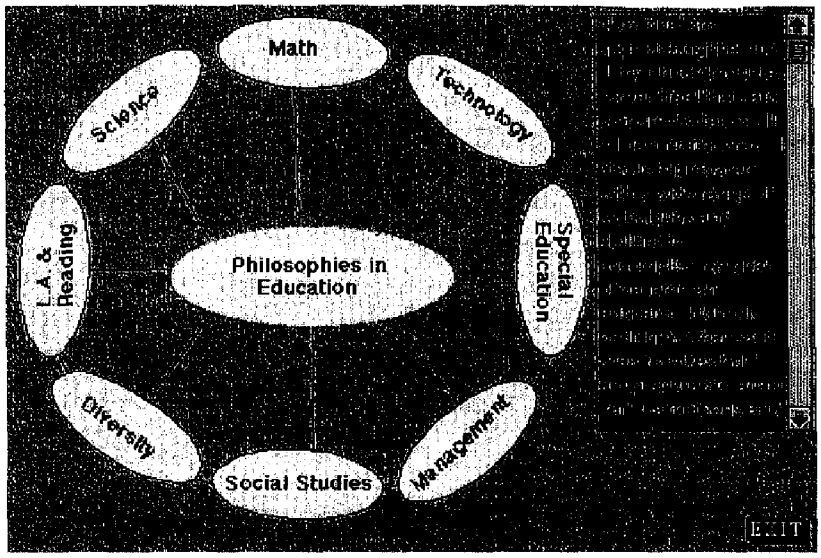


Figure 2



and in their reflective commentary. Gina noted, "...this [portfolio] just shows what I want—because you only have so much room. You have to pick out the most important things." Interestingly, in discussing differences between electronic and traditional portfolios, they seemed to equate a more selective and reflective stance to technology rather than to the portfolio process itself. For example, Patty stated: "I put in the good and I put in the bad. But I told what was good about it and what was bad. You can't just see that from a lesson whereas I could clearly state that on the screen by saying this is what I like about it, this is what I didn't like about it. It was more reflection."

Technology, on the other hand, has the potential to encourage "fluff" at the expense of content in an effort to impress others or because of a tendency to want to "play" with some of the bells and whistles, as Julie expressed,

> You know, is it impressive because I have sound in it or hand claps or a boing everytime my button goes off? That's the problem I have; it's too easy to get caught up in making it look nice. The portfolio ...does make you revisit everything. But you revisit in paper and you revisit in electronic form; it's the same. I don't think there is much difference.

Responses to several of the survey questions (see Table 2) reinforce both a positive view and an openness to technology on the part of these five students when compared to the other students in the CLIMB cohort who chose not to continue developing electronic portfolios. For example, for question 28, I *am confident in my ability to teach using computers*, the mean of 4.6 for the electronic portfolio group was higher than the mean of 3.9 for the non-electronic group. Questions 26 and 39 suggest that the electronic portfolio group felt less discomfort and "hostility" toward computers. One of the largest differences is question 17, *Time for learning new technologies is a problem.* Time to learn and practice is commonly mentioned in the research literature as a factor inhibiting the use of technology. In spite of the fact that four of the five students who developed electronic portfolios were going to school and working at the same time, this group seemed to consider time less an issue than the other group (2.6 vs. 3.5).

One of the students in the non-electronic group wrote in response to an open-ended question on the survey: "I do not think I will be doing an electronic portfolio again. It makes me sick just to think about it. Also we have *no* time and I don't have a Mac at home." While the first part of her comment is fairly extreme in terms of feelings about constructing a second electronic portfolio, the second two aspects—no time and lack of a Mac at home—are fairly representative of the CLIMB group and the larger population of teachers struggling to integrate technology.

How have views about portfolios and the inclusion of technology changed over time and with experience? Based on written responses to the informant questionnaire and during the focus group interview, these students characterized changes in terms of greater expertise, confidence, and understanding of the purposes of

portfolios and potential for using them in classrooms with children. They expressed greater familiarity with both the potential and limitations of portfolios, comparing their most recent portfolios to ones they had constructed as part of their initial Introduction to Education (201) class prior to entering the CLIMB program.

Table 2
Selected Mean Responses to Survey of Students
Who Constructed Electronic and Non-electronic Portfolios
(1=low, 5=high)

		Electronic N= 5	*Non-electronic* N= 16
Confidence			
28	I am confident in my ability to teach using computers.	4.6	3.9
34	I can develop lessons integrating computers for instruction.	4.6	4.6
Beliefs/attitudes about technology			
24	I believe computers should be an integral part of classroom instruction.	5.0	5.3
26	Computers make me feel uncomfortable.	1.8	2.8
35	Computers in education create an additional burden for teachers.	2.6	2.3
39	I feel hostile toward computers.	1.4	2.2
43	I enjoy working with computers.	5.2	5.1
Responses to traditional impediments			
17	Time for learning new technologies is a problem for me.	2.6	3.5
19	I currently have technology support available at UNLV.	5.2	4.8
44	I have seen technology use modeled by professors during my methods courses.	4.4	4.1
45	I have technology support available from my Practicum teacher or the technology coordinator at the school.	4.2	3.7
Skills/expertise related to technology			
27	I can capture video and place it in other documents programs on the computer.	3.2	3.1
29	I can use a scanner to copy images for use in projects.	5.0	3.5
30	I can design, create, & implement multimedia projects.	4.6	4.4
37	I can move information from one software application to another on the computer.	4.8	4.5
38	I can use a digital camera to take pictures & use them in projects.	2.8	2.8
46	I can teach word processing.	5.2	5.3
47	I can teach graphics.	4.2	3.7
48	I can teach data base software.	4.4	3.7
49	I can teach spreadsheets.	4.0	3.8
50	I can teach multimedia software.	4.6	4.1

Rhonda's statement typifies this idea: "In my first portfolio, in no way, shape or form did I go back and do any kind of reflection or any kind of synthesizing of the information." As Julie explained, "In 201, when you were a lot younger in your career, reflection wasn't there!" While Jolene commented, "Doing an electronic portfolio the second time seems much less intimidating", Patty explained how she had grown to understand classroom potential,

> I see the importance more now [than when it] was introduced in Tests and Measurements.... I think that by doing the electronic portfolio, like I said, it's more personal for kids. It lets them choose what they want, and it also makes them support why they chose what they did. I mean, I thought more about what I was putting into my portfolio, so I'm sure if I did, they would too.

Jolene also explained how she had developed a greater sense of audience:

> The only different thing I was thinking of was if someone is going to be looking at my portfolio, they're not going to want anything very lengthy or long. So I'm changing it a little bit in that there's probably more bullet statements. Like when someone looks at it, they can see right away what my philosophy in math is rather than a great big long running record and then having it go someplace else to show examples.

The analysis of the portfolios by the reviewers corresponded with the views expressed by students. The reviewers found "less focus on bells and whistles," "greater awareness of the needs of viewers," "shifts in thinking to a nonlinear form, thus taking advantage of multimedia capabilities," "a greater willingness to experiment the second time through," and "development of professional voice."

What are the necessary support structures for developing electronic portfolios? There were a number of supporting factors mentioned in the questionnaire and interview which can be characterized as physical and human resources. Students specified access to computers, a scanner, recorder, and camera. In addition, they mentioned the need for computer time, and help from support staff when needed, along with some instruction on how to use equipment and programs. When asked to specifically talk about their own experiences, they noted the support the CLIMB cohort provided to each other, including the ability to "bounce ideas around." They felt that the integrated nature of the program also facilitated their ability to form links, and they appreciated having technical expertise available. While Christy was available at times, they also grew to rely on each other and more extensively on Patty who was viewed as possessing the most expertise of the CLIMB students.

What are the impediments? The impediments mentioned by these five students reflect those that are typically raised in the research literature in relation to the integration of technology, and to some extent, to portfolios. Time continues to be a factor. Although time is clearly related to the learning of technology, it is also an issue with portfolios. The nature of portfolio assessment often necessitates waiting

Figure 3

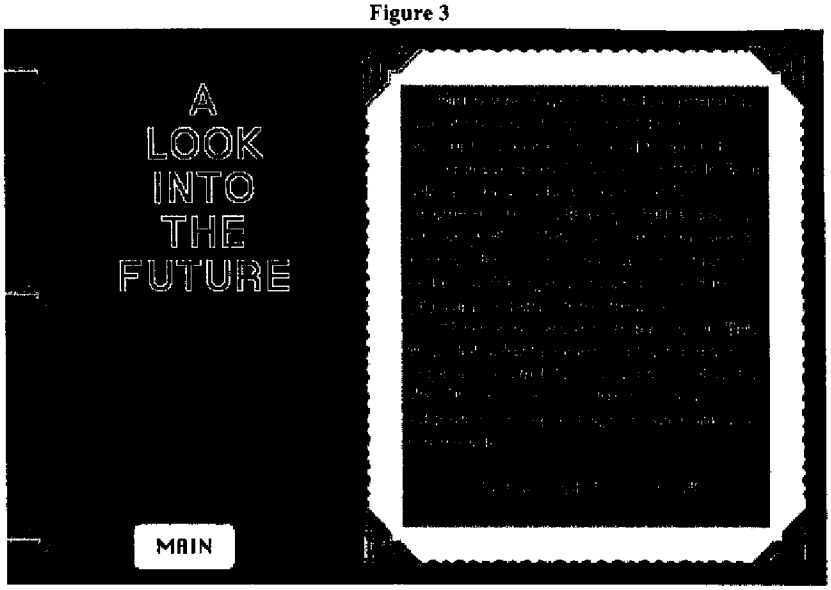
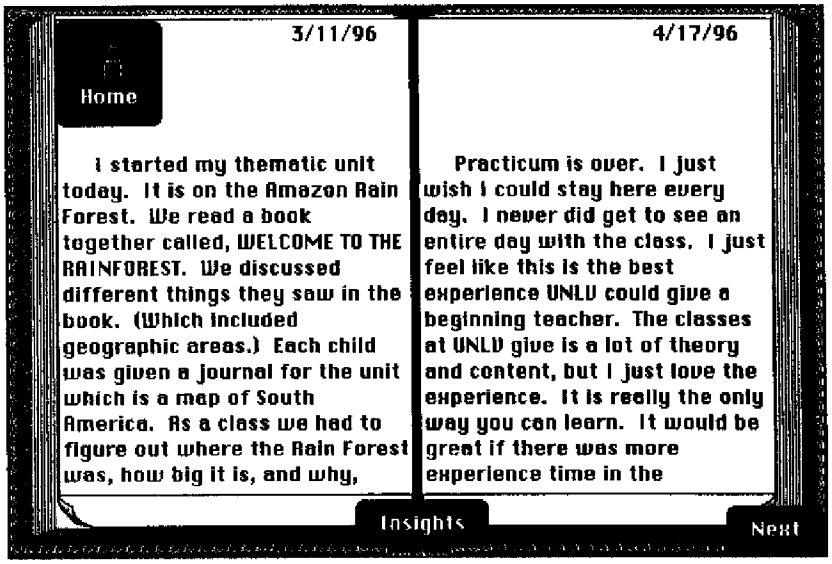


Figure 4



until the semester is nearly over to finish the selection and reflection processes. Because this is also the time when *everything* is due, there is tremendous pressure and anxiety, which in turn can make even small technological problems seem insurmountable. These students faced several problems with the authoring program as well as with the memory capability of some of the machines in the computer lab. For example, the program would freeze for no explicable reason, and moving from one computer to another in different labs at times meant that saving stacks to disks was unreliable. Coupled with limited disk space, the lack of access to this program at their home computers caused some students to feel frustrated that their visions of what they wanted to include (*e.g.*, more graphics, video clips, more links) had to be limited. There were also problems associated with platforms. Some students had IBMs at home and were very comfortable with using them. However, because they had learned HyperStudio at the university with Macs, they had difficulty transferring from one platform to the other.

Discussion

Creating electronic portfolios provided opportunities for the emerging teachers to be reflective through the way the portfolio development process built in the nature of reflection—requiring the setting of goals, journals, reflections on assignments, etc. Interestingly, several students equated the reflective quality of the portfolios with their electronic format rather than the way the portfolio process had been structured. The authoring software and memory limitations of computers used in this study limited the potential of the nonlinear format of hypermedia; this meant that our visions (students' and mine) of what could be included in the portfolios, and even the ability to extend portfolios from one semester to the next could not be fully realized. There was simply not room, and the program would freeze or crash when attempts were made to add more content. Thus, it appears that the integration of technology into portfolios has much potential and can facilitate reflective practice, but the software available, at least the program used in this study, made the inclusion of technology problematic.

The issue of time continues to be a challenge. On the one hand, as suggested above, there is never enough. Thus, as teacher educators, we face the issue of how to balance the benefits of incorporating portfolio self-assessment (with all of the support necessary to facilitate the process) with the need to cover content. Increased efforts to integrate field based components adds another factor into the cost-benefit equation. Until portfolios and technology become more established as part of the culture of teacher education programs and partner schools, it is unlikely that this issue will be resolved.

This project focused on five emerging teachers who were in general proficient and confident in their use of technology. They wanted to continue developing electronic portfolios, saw the potential of the technology for themselves and for use

in their future classrooms, and thus volunteered to be part of the study. This is consistent with the research literature on change and innovation, that it is most effective with people who are volunteers; then, as the culture evolves to support its use, it may become more fully integrated and/or used by people who were hanging back, waiting. A number of impediments apparently prevented other students from deciding to continue to develop their electronic portfolios. Thus, in the future, it may be necessary to explore whether other technologies such as web pages would make it easier. However, as the technology becomes more open-ended, and allows more "space" with easier links to many sites, it will still be important to alert students to factors that distinguish effective portfolios from ineffective ones—"moving van portfolios" that incorporate everything with no selection or reflection are still unacceptable as tools for self-assessment.

In dealing with portfolios in teacher education programs, we need to see further longitudinal work related to how portfolios are used, including their effectiveness, how to structure their development and how to support their use—in individual courses and through programs. The results of this study suggest there is some value in scaffolding the development of portfolios over time. In doing so, it is important to involve students in the process. The five emerging teachers in this study indicate that continuing to develop portfolios allowed them to see their growth over time. In addition, they become more comfortable with their understanding of how they want their portfolios to look, what they wanted to communicate, and how to best use and incorporate technology. There was a clear development of professional voice that emerged over the span of the two portfolios. In terms of program development, it appears that programs such as CLIMB that foster integration of methods courses with each other and with field experiences facilitate integration within portfolios. Students indicated that because courses were linked, it was easier to make connections in their portfolios; the ability to form links through hypermedia technology also enhanced this opportunity. If we advocate such integration in the schools for which we are preparing our future students, it seems important that we continue to be open to such possibilities as teacher educators.

While there were limitations to the program that was used to create the electronic portfolios for this study, it is important to point out some of the benefits/ insights that were apparent in the use of this medium for purposes of evaluating learner growth, courses and programs. Clearly, portfolios in any format have the potential to allow the learner to step back and reflect on the learning that has occurred over the course of a semester and in some cases, over a program. It was instructive for me, as a teacher educator, as a course instructor, and as a faculty member actively involved in the CLIMB program, to have the opportunity to review the electronic portfolios from two semesters of work. Although I had participated in each conference for the 23 CLIMB students when they constructed electronic portfolios that were to connect my literacy methods class with their other coursework and field experiences, I found it helpful to reexamine two semesters of

portfolios from the five students in this study. The electronic medium clearly facilitated the ability to do so. I could work at home since I had copied the portfolios onto a zip disk and had access to HyperStudio. The only exception was Julie's second IBM portfolio for which I had to use a computer in the lab. Thus, storage is a clear benefit of electronic portfolios compared to conventional paper portfolios.

But more than that, it was an indicator of the effectiveness of the teacher education program we had all been a part of. The two reviewers and I saw clear evidence of growth of knowledge over time and the development of professionalism. A unifying voice at the end of each of the second portfolios seemed to suggest a readiness to begin their student teaching experience and indeed, their teaching careers with a sense of confidence. One of the reviewers noted that "goals evolved from 'Collections of things' to personal refinement of techniques and styles." Patty's final comment in her second portfolio lends credence to the effectiveness of the program and to her readiness to move forward in her career:

> Now that I approach my final semester of student teaching I feel I'm as prepared as I ever could be. It seemed so long ago that I was just beginning with Introduction to Elementary Education and now I am one semester away from graduating. I feel I got the most these last few semesters because they contained the methods classes.... Those classes contained all the information that I need to start off with in my classroom. I feel that I got the best resources, the best instructors, the best opportunity of two unique schools and the best opportunity to meet and collaborate with a group of people I call my friends. The C.L.I.M.B. situation allowed me to gain the most I could in the elementary education program and at the same time allowed me to experience cohesiveness among my peers. Now it is time to be "reintroduced" into the field. I know that I have 22 other colleagues to call on if I need help or resources. Too bad not everyone has that same feeling.

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