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Abstract

Pre-service teachers’ perceptions of their gains in technology skills in courses with embedded technologies were investigated using retrospective pretest methodology. Pre-service teachers perceived themselves to have made significant gains in their technology skills and in their attitudes toward use of technology in their future classrooms. Answers to open-ended questions indicated that those students who had succeeded in upgrading their skills through applied effort were more likely to state they would include technology skill development for students in their future classrooms. Pre-service teachers least likely to include technology skill development for their future students were those whose attitudes and experience relative to technology were least positive. Use of retrospective pretest methodology may have been a factor in reducing threats to internal validity from response-shift bias in this study.
Evaluation of Pre-service Teachers’ Perceptions of Technology Skills Improvement Using Retrospective Pretests

Pre-service teachers need to know how to use the tools of information and communication technology as they develop their professional skills, attitudes, and dispositions leading to a successful career. Acquisition of technology skills requires teacher candidates to gain declarative, procedural, and strategic knowledge (Schulman, 1986) for the application of technology to the practice of teaching. This is not an easy task. Teacher preparation programs across the country are engaged in trying to infuse technology in teacher preparation programs through Preparing Tomorrow’s Teachers to Use Technology (PT3), a federal program administered by the United States Department of Education. Since 1999, the PT3 program has given out $337.5 million to 441 education consortia throughout the United States (http://www.ed.gov/offices/OPE/PPI/teachtech/).

The authors currently are actively involved in one such grant in a college of education at a medium-size, land grant university in the West. This three-year grant, named Project Learning Links, is based on the belief that, to efficiently use learning technology in a school classroom, teachers must think differently about the teaching and learning process, classroom organization, methods of content delivery, and the nature of student projects and assignments. To accomplish this, teacher preparation programs in elementary, secondary, and special education are being adapted and transformed. There are four change components in the teacher preparation program:

1. **Modeling:** Future teachers observe technology-enhanced teaching in
action in their university course work.

2. **Integrating**: Technology applications and assignments are taught in pedagogy courses in all the teacher preparation programs.

3. **Enhancing**: Future teachers develop trouble-shooting and technical skills to enable them to maintain technology-rich classroom environments.

4. **Applying**: Future teachers use their knowledge of technology in teaching and learning in field-based and online experiences with school children throughout the state.

These four components comprise system wide changes in the way classes are taught, skills are demonstrated, and performance is assessed. The synthesis of these change components occurs in the Faculty Fellowship segment of Project Learning Links. Each semester, faculty may apply for a fellowship through the grant. The application asks the applicant to detail how s/he will re-design an undergraduate teacher preparation course to include technology in her/his teaching and in student assignments. After review by the grant management committee, five Faculty Fellows are selected for support. Each is matched with one of two graduate assistants employed by the grant, depending on the details of the fellowship and the expertise of the graduate student. The graduate student acts as mentor, coach, teacher and general technology resource to the Faculty Fellow for the duration of the fellowship. In addition to receiving graduate student support, each Faculty Fellow may purchase up to $1,000.00 of hardware and/or software for course enhancements.

To date, 25 Faculty Fellows have transformed more than 27 courses. Some faculty wanted to incorporate PowerPoint into their classes; others wanted to get their
classes online via WebCT; still others wanted to incorporate digital cameras, scanners, video editing, or Web site building into the classes they teach. Ongoing evaluation each semester of each class shows remarkable progress by faculty and students alike. This paper reports the results of one such semester’s worth of data from three Faculty Fellows, using methodology that the authors believe more accurately reflects gains in pre-service teachers’ technology skills than the more traditional pretest/posttest methodology. Using traditional pre/posttest design to measure the effects of a training intervention may result in response-shift bias, which poses a threat to internal validity.

Response-Shift Bias

A basic assumption for the validity of self-reporting in pre-/posttests is that the underlying metric a respondent employs when completing both the pretest and the posttest remains the same for both points in time (Cronbach & Furby, 1970). However, at pretest, subjects may have only a partial understanding of the skill to be measured. As they proceed through the training, respondents gain experience with the skill that may change their perceptions. Thus, by the end of the training, their views, beliefs, and behaviors relative to the skill are different; and, while the scale of the posttest measurement instrument, a Likert scale in this case, remains the same, respondents’ underlying metric has been recalibrated (Aiken & West, 1990). This recalibration, known as response-shift bias, is the result of a shifting of respondents’ perceptions of themselves. Response-shift bias thus poses a threat to the interval validity of the instrument.
Theoretical Framework

*Embedding Technology into Pre-service Teacher Education*

The basis for the PT3 program was laid in the 1983 report from the National Commission on Excellence in Education titled *A Nation at Risk*, which concluded that America's educational system was so poor that America's competitive future was threatened. This prompted a wave of reforms in schools and teacher education that has yet to crest. In 1995 the Office of Technology Assessment (OTA) released a report, *Teachers & Technology: Making the Connection*, uncovering the lack of technology preparation in teacher preparation programs, and finding that "most technology instruction . . . is teaching about technology . . . not teaching with technology across the curriculum" (OTA, 1995, p. 165). Between 1996 and 1999 reports from the U.S. Department of Education, the National Commission on Teaching & America's Future, NCATE, the Teacher Education Accreditation Council, the American Association of Colleges of Teacher Education, the Milken Exchange on Education Technology, the American Association of State Colleges and Universities, and the American Council on Education (ACE), among others, called for a national emphasis on technology infusion training in teacher preparation programs and to take the lead in moving the education of teachers to the center of the institutional agenda (ACE, 1999). This was the same year that PT3 awarded its first grants, totaling $75 million.

As at least a partial result of the PT3 program, there is an emerging understanding of what elements must be present in teacher preparation programs in order for the teachers they graduate to be better able to infuse technology into their K-12 classrooms. Integrating technology by the faculty member into all aspects of the course and requiring
students to integrate technology into all their course work seem to be two of the most effective elements (Di, Dunn, & Lee, 2000; Johnson-Gentile, Lonberger, Parana, & West, 2000; Sherry, 2000; Strudler & Wetzel, 1999). Moursund and Bielefeldt (1999) found that most college of education faculty feel that technology is not effectively modeled for pre-service teachers. Zehr (1997) concurs, finding that faculty who do not model technology produce pre-service teachers who are less inclined to use technology in their own classrooms.

Knowledge of technology does not translate into its use in the classroom, however. A 1998 study found that while 100% of faculty used technology in their offices or at home, only 33% used it in the classroom or required their students to use it (Lewallen, 1998). Strudler and Wetzel (1999) stated that faculty “must see a fit between their philosophies of teaching and learning and technology applications.” Fullan (1998) suggested that pressure can also be a critical element for successful integration, where pressure is defined as the implicit or explicit expectations that faculty will integrate technology or the explicit expectations that students will integrate technology.

Learning Links Faculty Fellows are required to model the technology they propose to learn, and to require its use by their students. The application process encourages the faculty member to think about and rationalize the pedagogical reasons for their use of technology, as well as to discuss how it will benefit the class in general and pre-service teacher education in particular. As evaluation of this project is ongoing, the authors are always interested in showing the progress the faculty and students make, and some recent work with retrospective pretest methodology shows promise for this purpose.
Retrospective Pretest Methodology

Response-shift occurs when a respondent’s internal metric or frame of reference is changed during the time between the pretest and the posttest due to the effects of a training program or other intervention. Howard and his colleagues (Howard, 1982; Howard & Dailey, 1979; Howard et al., 1979; Terborg, Howard, & Maxwell, 1980) found that when self-reports are used to evaluate change after a training program, participants use an altered set of scale units to classify themselves. This disruption of the internal metric used for the pretest compared to that used for the posttest poses a threat to the internal validity of the instrument, which Howard labeled as response-shift bias.

An alternative to the traditional or initial pretest is the retrospective pretest, which is administered after the posttest. Respondents are first asked to complete the posttest, which serves as an anchor or benchmark of where they currently perceive themselves to be relative to the construct of interest. Then they are asked to take the test again and answer by recalling how they were functioning just prior to the start of the program. Because the pretest and the posttest are taken at the same point in time, respondents’ internal metric remains the same and the response-shift bias has been removed. Howard and his colleagues have repeatedly found such retrospective pretests to yield higher statistical power and to be more highly correlated with external measures of constructs of interest than their respective initial pretests, thus leading them to argue in support of using retrospective pretests in change-score analyses from pretest to posttest (Bray, Maxwell, & Howard, 1984; Howard et al., 1979).

Most of the research involving retrospective pretests has been done in the field of psychology and has focused on behaviors such as assertiveness training, leadership skill
acquisition, and the like. One study was found in the area of drug research in clinical psychology (Aiken & West, 1990) and one in the field of education (Bray & Howard, 1980). Researchers working in the area of program evaluation have also found that retrospective pretests may provide a more sensitive and valid measure of effects (Skeff, 1992). While the use of retrospective pretests is not common in educational research, the notion of using them to increase the internal validity of educational measurement instruments is intriguing. In follow-up interviews of respondents in a study comparing traditional pretests to retrospective pretests, Cantrell (2003) found that pre-service teachers had overrated themselves consistently on the traditional pretests. When asked how they could explain the discrepancy between their ratings on the traditional pretest compared to the retrospective pretest, respondents suggested that they had assumed an understanding of the construct on the first day of class. However, after spending a semester gaining experience and understanding, they acknowledged that they did not have a clear basis for judgment until the end of the course.

Methods and Procedures

The sample for this study included 102 pre-service teachers enrolled in three undergraduate courses. One course was a three-credit special education survey course in which the Faculty Fellow embedded presentation software skills and included an online component that required students to upload files to a Web server. The second course was a six-credit elementary math methods/practicum course. Students were required to complete a technology contract wherein they targeted three specific technology skills (excluding word processing) of their own choosing to upgrade throughout the semester. They were to use these technology skills to complete various course assignments during
the semester. The third course was a three-credit elementary science practicum. Students were required to utilize technology in the development of their lesson plans that were subsequently taught in elementary school classrooms. They were also required to use technology to document evidence of student achievement in their assigned elementary classrooms. Digital video and still cameras were made available to the students in the last two courses, and a portion of class time at the university was set aside by the Faculty Fellow for training the pre-service teachers in the skills required to operate the cameras and export the images into other formats such as movie clips, presentation software, and Web-ready image formats.

Instrumentation

The Learning Links Technology Questionnaire (LLTQ) was developed to survey undergraduate students enrolled in the courses taught by Faculty Fellows. In order to address the broad range of technology skills targeted by the Faculty Fellows, the content of the Faculty Fellow application forms was analyzed, wherein the applicants were to describe in detail how they would embed technology skills for pre-service teachers in their existing courses. From this analysis, the 12 skills that occurred with the greatest frequency were selected. Five additional questions were then developed, with the intent of eliciting an indication about pre-service teachers’ attitudes about current and future use of technology in their classrooms.

The LLTQ (see Appendix) asks students to rate their perceptions of their skill level on the 12 skills according to the Nevada Technology Skill Proficiency Scale:
1. **Early:** Learners at this level are exploring technology and developing foundational skills but have not developed sufficient expertise to meet Nevada Standards.

2. **Emergent:** Learners at this level continue to explore technology and have developed the skills enabling them to use technology when prompted. They are approaching the Nevada Standards level.

3. **Fluent:** Learners at this level select and apply appropriate technology to successfully complete tasks. Their skills meet the Nevada Standards.

4. **Proficient:** Learners at this level create new knowledge and analyze resources within the context of their curriculum. They also share their new knowledge through proactive modeling, peer coaching, and mentoring. Their skills exceed the Nevada Standards.

The LLTQ was administered to all students on the last day of their respective courses. The first 12 items asked for a proficiency rating of their skill level as of the last day of class. The next 12 items were an exact replica of the first 12, but asked students to reflect back to the first day of class and provide a proficiency rating for their skill level on that day. This was the retrospective pretest portion of the questionnaire. Each of the five attitude items was paired with an item asking for how they would have responded to the same question on the first day of class in order to provide a retrospective pretest of each of those items.

The 12 skill items were combined into the Skills Scale and analyzed for internal reliability using Cronbach’s alpha, which yielded a reliability coefficient of .88. The five attitude items were combined into the Attitude Scale. Cronbach’s alpha coefficient for
this scale was .76. Coefficients of .70 or above are acceptable using Cronbach’s alpha (Nunnaly, 1978).

Items 1 through 12 were totaled for the post Skills Scale, and items 13 through 24 were totaled for the retrospective pretest Skills Scale. Items 25, 27, 29, 31, and 33 were totaled for the posttest Attitude Scale, and items 26, 28, 30, 32, and 34 were totaled for the retrospective pretest Attitude Scale. Means for pre- and posttests were compared using paired sample $t$-tests. Effect sizes are reported as a measure of the magnitude and practical difference between means. Effect sizes in this study are in a generalized form as the ratio of the difference between the group means divided by the estimated standard deviation of the population (Cohen, 1988). All effect sizes were calculated by using the pretest standard deviation as the estimated standard deviation of the population. According to Cohen (1988), an effect size of approximately .20 is considered to be small, while .50 is moderate and .80 is large.

Pre-service teachers were also presented with two open-ended questions assessing their evaluation of technology skills acquired through the course in relation to their future teaching careers. The first of these questions sought to identify the specific technologies students thought would be valuable to their future work. The second question asked if they would teach technology skills beyond those introduced in weekly computer lab sessions. These two open-ended questions were qualitatively analyzed for content.

Results

Significant differences were found between the means of the retrospective pretest and the posttest for both the Skills Scale and the Attitude Scale on the LLTQ. Descriptive statistics are found in Table 1.
Table 1

Descriptive Statistics for Skills Scale and Attitude Scale

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Skills Scale</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Retrospective Pretest</td>
<td>102</td>
<td>20.23</td>
<td>7.70</td>
</tr>
<tr>
<td>Posttest</td>
<td>102</td>
<td>24.62</td>
<td>8.41</td>
</tr>
<tr>
<td><strong>Attitude Scale</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Retrospective Pretest</td>
<td>102</td>
<td>35.19</td>
<td>10.95</td>
</tr>
<tr>
<td>Posttest</td>
<td>102</td>
<td>43.50</td>
<td>8.80</td>
</tr>
</tbody>
</table>

Students perceived themselves to have made significant gains in their technology skills \( (t_{101} = 7.39; p < .001) \) with a moderate effect size of .57 and in their attitude toward use of technology in their professional lives \( (t_{101} = 9.55; p < .001) \) with a moderate to large effect size of .76.

*Open-Ended Questions*

Students reported a variety of technology skills as being the most valuable for their future teaching. PowerPoint was selected by 38% of the students. One student responded, “PowerPoint is a visual presentation that can often allow [a] child to learn easier. I personally am a visual learner.” Another student stated, “PowerPoint makes taking notes more interesting and easier.” Digital camera skills were selected by 23% of the students and were perceived as functional tools for documenting learning. One student stated, “Digital cameras are a great way to record student work and have easy access to pictures via the computer in the classroom.” Another student stated, “This [use
of a digital camera] was great because it was so helpful as we did our projects to record our progress. I think kids would feel real important using this technology.”

Several other technology skills were selected by fewer students: Internet searches (8%), digital video editing (6%), Web page development (5%), importing pictures to Word (4%), and using WebCT (3%). In gaining experience doing Internet searches, one student reported, “I was horrible at searching for specific topics where I didn’t know a Web site. We had to do it, so now I’ve learned ways that make it easier, such as using search engines.” Eighteen of the students did not respond to this question and several of the students did not identify a specific technology or skill in their answer.

With regard to the second open-ended question of whether the pre-service teachers will teach technology skills to their own students beyond what their students learn in weekly computer lab sessions, over 60% gave a positive response. Justifications for such a decision included: “I will definitely spend time teaching technology to my students because it is so helpful. Even though it is frustrating at times, once you get the hang of it, it can open so many doors and opportunities for student learning” and “Yes, because they shouldn’t have to wait until high school or college to experience technology in their classes.” Only a few of the pre-service teachers, roughly 12%, indicated they might or might not teach technology skills above and beyond the weekly lab sessions. Of these 12%, half indicated that their decision would depend on the situation such as students’ ages, time, and resources. The other half indicated that their decision would depend upon their becoming more proficient users. Only 8% of the pre-service teachers indicated they would not teach technology skills beyond the weekly lab sessions because of several different factors including: limited time, limited proficiency and interest,
dealing with young students, and standards of their school do not include these technologies. One student in this category responded, “No, they [students] will be too young and need to learn other basic skills.” Another stated, “No, I didn’t like technology that much and don’t plan on wasting my time on that.” Twenty of the students did not respond to this question or were not sure.

Discussion

Most pre-service teachers in this study perceived an increase in their skills and attitudes toward technology during the semester. It seemed apparent that requiring pre-service teachers to utilize the technology skills for successful completion of course assignments was a contributing factor to their growth. Several students commented on having to increase their skills to meet assignment expectations. Another contributing factor for some students was seeing the Faculty Fellow model the technology. One student expressed surprise at “seeing what PowerPoint could do,” while another student noted that “our instructor used it [PowerPoint] too.”

Most students reported that their future classrooms will include technology skills development for their students because such skills are critical for success in society today. A few students displayed delightful enthusiasm about including technology training in their classrooms by calling it “fun” and stating how much they will “love to” teach technology skills to their future students. It seemed that students with positive attitudes toward technology were those whose proficiency levels had increased over the semester. One student who stated that she valued “just about everything” that she learned about technology also stated, “I will definitely spend time teaching technology to my students because it is so helpful. Even though it is frustrating at times, once you get the
hang of it, it can open so many doors and opportunities for student learning.” She indicated a struggle to gain her skills, but now that she has acquired proficiency, she intends to pass it on to her students. Other research supports this idea. In a study of over 4000 teachers, Becker (1999) found that the level of technology skills taught in classrooms was positively related to the proficiency level of the teacher, and that by far the most common use of technology was for word processing. The pre-service teachers in this study at the opposite end of the spectrum also support this notion. One student stated, “If I personally become educated on technology, then I will teach it to my students. But if I don’t feel comfortable with technology I will not teach it.” Another student said, “I am not proficient with many things beyond word processing, so if I do [teach technology skills] it will be just the basics.”

The findings of this study suggest that pre-service teachers enrolled in courses that included embedded technologies and required skill development do perceive that their technology skills and attitudes increase over the semester. Evaluating the gain scores using retrospective pretests also may have reduced the threat to internal validity caused by response-shift bias. While the threat to internal validity caused by response-shift bias may have been reduced, retrospective pretests may increase other threats to internal validity, such as effort justification or social desirability. With their posttest answer choices fresh in their minds when they take the retrospective pretest, students may be inclined to present themselves in a more favorable light by deliberately rating themselves low to produce greater change scores in order to justify their effort. However, not all students felt the need to justify their effort, as indicated by a few students who stated, “I didn’t learn any new technology in this class.” In the field of psychology,
social desirability responding and effort justification have each been studied for their effects on response-shift with treatments resulting in effective control of these threats (Sprangers, 1987). Similar treatments could be designed and investigated for effectiveness in education settings.

Conclusions

The PT3 funding for the grant enabled the Faculty Fellows to purchase technology and obtain training support from the graduate assistants funded by the grant to raise their own technology skills proficiency level. In turn, they embedded technology skill acquisition into their undergraduate courses, resulting in perceived gains in technology skills and attitudes by the pre-service teachers. The two contributing factors that emerged from the content analysis of the LLTQ open-ended questions were first, the Faculty Fellows modeled the very skills they hoped their pre-service students would acquire; and second, the skills were embedded in course assignments and requirements. Enthusiasm for technology on the part of the pre-service teachers seemed to be related to the success they had in acquiring the skill levels necessary to successfully complete the assignment. Many pre-service teachers demonstrated a willingness to spend whatever time and energy it took to succeed, and most had a very positive attitude about including technology skills as part of the curriculum in their future classrooms.

More work needs to be done in the area of retrospective pretests in education to examine their viability as a data collection technique. The results, while positive, must be interpreted with caution with respect to threats to internal validity from effort justification and social desirability. Future studies could include methods for providing
evidence for convergent validity, which would lend support for the use of retrospective pretest methodology in educational research.
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Appendix

Technology Questionnaire

You are being asked these questions because you have spent time in a course with embedded technologies that were intended to support your learning. Please respond with the rating that best reflects your impressions about this experience.

Use the following scale for the items below:

1 = Early
Learners at this level are exploring technology and developing foundational skills.

2 = Emergent
Learners at this level continue to explore technology and have developed the skills enabling them to use technology when prompted.

3 = Fluent
Learners at this level select and apply appropriate technology to successfully complete tasks.

4 = Proficient
Learners at this level create new knowledge and analyze resources within the context of their curriculum. They also share their new knowledge through proactive modeling, peer coaching, and mentoring.

Please rate your skill level as of TODAY for the items below by circling the appropriate number according to the indicated scale above

1. Use a digital still shot camera                        1 2 3 4
2. Use a digital movie camera                          1 2 3 4
3. Edit a movie clip using iMovie (or similar software) 1 2 3 4
4. Insert a photo into a word processing document      1 2 3 4
5. Create a PowerPoint (or other presentation software) document 1 2 3 4
6. Insert a digital photo into a PowerPoint document    1 2 3 4
7. Insert a movie clip into a PowerPoint document       1 2 3 4
8. Create a Web page using Netscape Compose or other software 1 2 3 4
9. Upload a text file to a Web page (i.e. WebCT)         1 2 3 4
10. Upload a photo or movie clip to a Web page (i.e., WebCT) 1 2 3 4
11. Communicate online in class discussions (threaded discussions) 1 2 3 4
12. Use a class electronic bulletin board for communication 1 2 3 4

Please rate your skill level as of the FIRST day of class for the items below by circling the appropriate number according to the indicated scale above

13. Use a digital still shot camera                        1 2 3 4
14. Use a digital movie camera                          1 2 3 4
15. Edit a movie clip using iMovie (or similar software) 1 2 3 4
16. Insert a photo into a word processing document      1 2 3 4
17. Create a PowerPoint (or other presentation software) document 1 2 3 4
18. Insert a digital photo into a PowerPoint document    1 2 3 4
19. Insert a movie clip into a PowerPoint document       1 2 3 4
20. Create a Web page using Netscape Compose or other software 1 2 3 4
21. Upload a text file to a Web page (i.e. WebCT)         1 2 3 4
22. Upload a photo or movie clip to a Web page (i.e., WebCT) 1 2 3 4
23. Communicate online in class discussions (threaded discussions) 1 2 3 4
24. Use a class electronic bulletin board for communication 1 2 3 4

Circle the number that best describes your level of agreement with each statement.

25. In my future classroom, I will _______ use presentation software (such as PowerPoint) in teaching lessons.

    1 2 3 4 5 6 7 8 9 10 11 12
26. Before taking this course, my answer for #25 would have been:
always
never

27. Teaching students to use technology is _____________________________.
not worth the time it takes
well worth the time it takes

28. Before taking this course, my answer for #27 would have been:
not worth the time it takes
well worth the time it takes

29. Learning and using the technology in this course __________ the course content learning.
supported
interfered with

30. Before taking this course, my answer for #29 would have been:
supported
interfered with

31. I feel ____________________ to teach and use technology in my future classroom.
poorly prepared
well prepared

32. Before taking this course, my answer for #31 would have been:
poorly prepared
well prepared

33. I can visualize __________________ ways I will use technology in my future classroom.
numerous
very few

34. Before taking this course, my answer for #33 would have been:
numerous
very few

35. In your opinion, which of the technologies you gained experience in using during this course
will be most valuable to you in your future teaching? ________________________________
Please give a rationale for your answer ___________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________

36. If we agree that learning technology can be time consuming and frustrating at times, do you
think you will spend time teaching technology skills to your own students beyond what they
will get in weekly computer lab sessions (largely word processing skills)? Please explain
your answer. ________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________