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Contrasts in Classroom Technology Use Between Beginning and Experienced Teachers

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Too often, technology integration has been measured through self-report surveys of use and outcomes (Bielefeldt, 2002). While these studies can be valuable, they are also limited. This study is a field test of an instrument designed to measure technology integration that adds the rare element of direct classroom observation. This study compares student uses of technology in the classrooms of experienced teachers and beginning teachers. Comparing and contrasting the classrooms of beginning and advanced teachers provides a framework for understanding the dimensions of technology integration. This study sought to create a rich picture of elementary students at work in both situations.

Keywords: Assessment, Technology Integration, Elementary School, Novice and Expert Teachers

INTRODUCTION

The National Education Technology Plan (Paige, 2004) called for more training of teachers and better training of those preparing to become teachers to use technology in the classroom. What would K-12 teachers and students be doing with technology if they were better prepared to integrate technology into their classes on a regular basis? What are the observable behaviors that encompass technology integration? Defining technology integration in the abstract, and even listing the skills that strong teachers should possess in this area (e.g., National Education Technology Standards – Teachers (ISTE, 2003)) is a relatively straightforward process as is querying teachers about technology use. What has proven far more difficult is the observation of technology use in the classroom. In this article we intend to make a contribution to the understanding of the issue by reporting on the results of a study comparing the integration of technology in the classrooms of experienced teachers and recent teacher education graduates using an instrument developed for this purpose.

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BACKGROUND OF STUDY

A Southwestern urban university received a three-year Preparing Tomorrows Teachers to Use Technology (PT3) 1999 Implementation grant. The purpose of the grant was to help faculty, experienced K-12 teachers and preservice students teach and learn with technology. The PT3 goals were twofold: a) to develop skills in preservice students so that they would integrate technology in their future K-12 classrooms, and b) provided training and support for experienced K-12 teachers in our partner school districts.

As they completed their teacher education programs, preservice students were to use appropriately a variety of technologies to accomplish their assignments and to design and implement lessons for K-12 students in their internship experiences. As a result it was hoped that they would become technology-integrating new teachers. By the conclusion of the PT3 project, College of Education faculty were using technology aligned with the National Education Technology Standards for Teachers (NETS-T) throughout their courses. (Wetzel & Williams, 2004). However, progress toward the first goal, that recent graduates would use technology with K-12 pupils, was harder to measure directly. Painter (2001) raises a number of important issues that remain unaddressed regarding both the extent and nature of technology use. Among these are: What is technology integration? What would it look like to an observer in K-12 classrooms? How does the evaluation differentiate between rating simple uses (drill and practice) and complex uses (productivity tools) involved in project-based learning? Two problems surface for evaluating the degree of technology use. The first is recording accurate observations of the classroom. The second is drawing conclusions from these data as to what they reveal about the degree and appropriateness of technology integration.

We began to think about the possibility of describing technology use in K-12 classrooms by comparing the elements of technology integration in beginning and experienced teachers' classrooms. Using the National Education Technology Standards for Students (ISTE, 2000) and Teachers (ISTE, 2003) as a basis for a standardized observation tool, we recorded behavioral indicators of technology use in the classrooms of experienced and beginning teachers with the goal of revealing significant differences. We then used those data to draw contrasts that may illuminate the development of technology-users. In the discussion section, we will also address the usefulness of the observation instrument, possible explanations for the findings and implications for preservice teacher preparation.

Factors Influencing Teacher Technology Integration

Over the past two decades progress has been made in describing accomplished K-8 teachers who design their classes so that students use technology in learning on a regular basis. In a national study of 1200 accomplished technology-integrating teachers, Sheingold & Hadley (1990) inquired about how they used computers and grouped students to use computers in the classroom and the barriers and incentives that had been important to them. With respect to the use of technology, they found that accomplished teachers: a) provided for multiple student uses of computers including instructional software (most frequently cited use: drill and practice 37%; tutorials: 24%) and tools (most frequently cited: word processing 75%), b) most often students made a product using the computer, and c) used more applications over time.

Based on their national survey of 4000 K-8 teachers, Becker and Ravitz (2001) also distinguish K-8 teachers whose students use technology more frequently from teachers whose students use less technology. They concluded that an adequate range of computers in the classroom and the elements of the teachers' constructivist philosophies were important factors.

EXPERT AND NOVICE TEACHER DECISION-MAKING

The decision-making of expert and novice teachers adds another dimension to our understanding of teachers and technology integration. Preservice students appear to make different decisions about the integration of technology in classroom scenarios than inservice teachers. Palacio-Cayetano, Schmier, Dexter, and Stevens (2002) used case-based simulations to identify and assess how teachers make decisions about integrating technology in the classroom. Comparing 67 inservice and 67 preservice teachers responses, the researchers found that inservice teachers addressed more key technology integration and implementation principles than preservice teachers. For example, inservice teachers raised issues of technology implementation, planning, and professional development, the computer as a learning tool, and cooperative learning two to three times as often as preservice teachers. Also, inservice teachers addressed linking the curriculum to technology far more frequently. These researchers concluded that although both groups of teachers had similar technology skills, that teaching experience is a significant influence on the quality of technology integration.

In another study of expert and novice teachers the researchers examined the focus of learning between five teacher education students completing their course work and elementary practica experiences and three teachers with 8-10 years of experience. Using qualitative analyses of audiotaped interviews and daily journal entries, Meskill, Mossop, DiAngelo, and Pasquate (2002) found that for experts the focus of learning was in teachers and students, but the focus of novice discourse was in computers. Novices attributed learning to the computer, experts to the learner. Beginning teachers focused on themselves as teachers, not on student learning. Further, novices focused more on controlling learners than the language and literacy of the students. For example, novices used the computer as a reward, experienced teachers as an opportunity to teach. These researchers also discuss the relative merit of formal course work and classroom experience. They conclude:

> Indeed, those novice teachers who had received "state of the art" training in classroom technologies were far less comfortable in their implementation than the more experienced teachers who had no formal training with computers but a great deal of classroom experience. (Meskill et al., 2002, p. 9)

The studies summarized above point to the importance of teaching experience in the decision-making of teachers. Many of them address the importance of the technical background of teachers, but in the Meskill et al. (2002) study, classroom experience in using technology with students was found to be more important than formal preservice course work.

In summary, there are a number of factors associated with teachers who use technology in their classroom to a greater extent than others. First there are the attributes of the teacher, such as the teacher's philosophy (Becker & Ravitz, 2001), and the compatibility of the technology with that philosophy (Zhao et al., 2002). Second, adequate access for teacher and students to technology increases integration (Sheingold & Hadley, 1990; Becker and Ravitz, 2001; Zhao et al., 2002). Third, teacher attributes, including motivation and commitment to professional development (Sheingold & Hadley, 1990) and professional engagement (Becker and Ravitz, 2001) were important factors. Fourth, researchers found differences between novice and expert teachers along several dimensions. Inservice teachers addressed more key technology integration and implementation principles than preservice teachers (Palacio-Cayetano et al., 2002) and focused more on the learning of the students as opposed to the technology (Meskill et al., 2002). Both Palacio-Cayetano et al., 2002, and Meskill et al. (2002) concluded that teaching experience has a significant influence on the quality of technology integration.

DEFINITION OF TECHNOLOGY INTEGRATION

Many studies use the term technology integration, but few define it and describe it behaviorally. For this study, we adopt Sun's definition: "…integration is the use of technology by students and teachers to enhance teaching and learning and to support existing curricular goals and objects" (Sun, 2000, p. 55**).** In this field test of the observation instrument, we focused on four aspects of technology integration, that is, student use of: a) subject specific programs, b) interactive communications tools, c) productivity tools, and d) research tools. The purpose of this study was to develop a more comprehensive understanding of technology integration in classrooms of experienced teachers and new teachers. The research question for the study was: Are there differences between beginning and experienced teachers in the integration of technology in classrooms? Four sub-questions were derived from the research question. They were:

1. Are there any differences between beginning and expert teachers in the portion of time students used subject specific software?
2. Are there any differences between beginning and expert teachers in the portion of time students used communication tools?
3. Are there any differences between beginning and expert teachers in the portion of time students used productivity tools?
4. Are there any differences between beginning and expert teachers in the portion of time students used research tools?

Data were collected through the use of the *Integration of Technology Observation Instrument* (Zambo, Wetzel, Buss, & Padgett, 2003). Although the instrument was designed to capture the roles of both the teacher and the students as well as the types and uses of technology and their frequency, this study focuses on the student uses and types of technology, as that is the end-goal in technology-equipped classrooms.

METHOD

PARTICIPANTS

The sample selected for this study was a purposeful sample consisting of two groups of K-8 teachers. One group was comprised of 18 experienced teachers participating in the Arizona Classrooms of Tomorrow Today (AZCOTT) project (Wetzel, Zambo, & Padgett, 2001). The 18 teachers were selected from a pool of 35 AZCOTT teachers based on school schedules. Experienced teachers had been teaching for 6-15 years with an average of nine years of K-8 teaching experience.

The other group was comprised of 28 beginning teachers who graduated from the Southwestern urban teacher education program two years earlier. They had participated in a college-wide Preparing Tomorrow's Teachers Project (PT3) targeting teacher education faculty and students to enhance their uses of technology in teaching and learning. The 28 beginning teachers were randomly selected from a sample of 224 elementary education graduates and were included in the study dependent on their willingness to participate. They had completed a teacher education program that included a required course in technology across the curriculum and extensive modeling of technology use by faculty in other education courses. Beginning teachers were observed in their second year of teaching.

Although both groups received a three credit hour course in educational technology, the course experiences were quite different. Topics were similar, but the experienced teachers were able to implement the lessons they created, evaluate and share them with peers. The preservice students also created technology rich lessons, but did not have their own classrooms to implement and evaluate the lessons.

Data collected outside the scope of this study using a self-report questionnaire (available at http://www.west.asu.edu/pt3/assessment/question.htm), indicated that both groups of teachers were equally confident in their abilities to integrate technology into their teaching and to troubleshoot any technological difficulties that might occur, two factors that could effect a teacher's inclination to use technology in the classroom. Participants' responses to Likert-type items, for example "I am confident in my ability to teach using computers" and "I can troubleshoot basic computer problems" were not significantly different.

Although the in-class technology access for beginning and experienced teachers differed, they both had access to one-to-one computing in their computer labs. Beginning teachers had a mean of 2.42 (median = 2.00) computers designated for student use in their classrooms. The experienced teachers had a mean of 8.70 (median=8.00) computers designated for student use in their classrooms. The mean number of computers in the computer labs of the schools of the beginning teachers was 29.87 and for experienced teachers 32.85. Data will be reported for beginning and experienced teachers overall and when both groups were in one computer-to-one student situations.

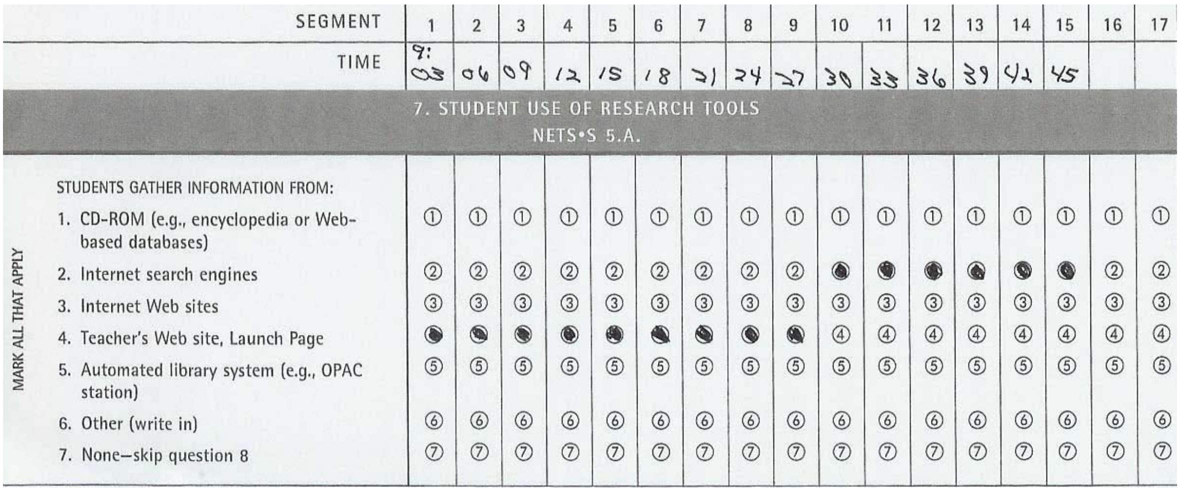
OBSERVATION INSTRUMENT

All observations were conducted using the *Integration of Technology Observation Instrument* (ITOI) (ISTE, 2003) developed through the support of a PT3 project. The starting point for the observation instrument was an existing instrument (*Classroom Observation Instrument for Nebraska PT3 Catalyst Project)* that had been developed by Mike Timms, Managing Director of the Center for Assessment and Evaluation of Student Learning (see the Timms' instrument at http://www.west.asu.edu/pt3/assessment/observation.htm). Using Timms' instrument as a focus of discussion, the Project Co-PIs and Project Staff revised the instrument based on our needs to examine more specific teacher and student uses of technology in classroom settings. The major difference between the original instrument and the revised version was the addition of items that elaborated on specific uses of technology by both teachers and students.

The ITOI was developed and pilot tested 2001-2002 (Zambo et al., 2003). The design of the ITOI was based on the National Education Standards for Teachers (NETS-T) (ISTE, 2003) and the National Education Standards for Students (NETS-S) (ISTE, 2000). The instrument has 11 subscales with six addressing student uses of technology in the classroom and five addressing teacher related areas such as the grouping of students. This study focuses on four of the six student uses of technology: subject specific software, productivity tools, interactive communication tools, and research tools. Each of the four variables measured in this study align with the NETS-S (ISTE, 2000). Two of the NETS-S (ISTE, 2000) were not addressed in this study *Social Issues* and *Problem Solving Tools*. *Social Issues* were not readily observable during a classroom visit and *Problem Solving Tools* presented difficulties in ascertaining cognitive levels of the activity observed.

Each of the four variables contained several subcategories. For example, in the area of *Student Use of Productivity Tools*, observers looked for use of the following: word-processing, presentation software, spreadsheets, databases, authoring, graphics, web authoring, and hardware. In addition, the instrument included categories to mark “other” in the case that a non-listed technology was used or “none” in case no technology was observed. To collect data, the observer checkmarks the presence of the category of technology integration observed during each three-minute interval. The checkmarks are then tallied for the three-minute intervals for an overall distribution of observed categories. When the teacher indicates the lesson begins, the observer is told to record observed technology use at three-minute intervals using the checkboxes. See the full ITOI instrument at http://www.west.asu.edu/pt3/assessment/observation.htm).

Figure 1 is the recording form for the category *Student Use of Productivity Tools* and illustrates the marks of the observer for a 45 minute classroom session. In this example, the observer recorded the first observation at 9:03, at which time the students were using the teacher’s launch page to conduct research. This continued until 9:27. Then the observer marked that the students were using a search engine from 9:27 to 9:45 to locate more information on the topic. Thus in this 45 minute class, students used the teacher’s launch page 60% of the time and an Internet search engine 40%. The other research tools were not used during this observed period.



SEGMENT	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
TIME	9:03	06	09	12	15	18	21	24	27	30	33	36	39	42	45		
7. STUDENT USE OF RESEARCH TOOLS NETS•S 5.A.																	
MARK ALL THAT APPLY — STUDENTS GATHER INFORMATION FROM:																	
1. CD-ROM (e.g., encyclopedia or Web-based databases)	①	①	①	①	①	①	①	①	①	①	①	①	①	①	①	①	①
2. Internet search engines	②	②	②	②	②	②	②	②	②	●	●	●	●	●	●	②	②
3. Internet Web sites	③	③	③	③	③	③	③	③	③	③	③	③	③	③	③	③	③
4. Teacher's Web site, Launch Page	●	●	●	●	●	●	●	●	●	④	④	④	④	④	④	④	④
5. Automated library system (e.g., OPAC station)	⑤	⑤	⑤	⑤	⑤	⑤	⑤	⑤	⑤	⑤	⑤	⑤	⑤	⑤	⑤	⑤	⑤
6. Other (write in)	⑥	⑥	⑥	⑥	⑥	⑥	⑥	⑥	⑥	⑥	⑥	⑥	⑥	⑥	⑥	⑥	⑥
7. None—skip question 8	⑦	⑦	⑦	⑦	⑦	⑦	⑦	⑦	⑦	⑦	⑦	⑦	⑦	⑦	⑦	⑦	⑦

Figure 1. Example of an Observer’s Record in a 45 Minute Period

PROCEDURE

The training of the three observers who collected the data for this research was conducted in three phases. In phase one they worked with Michael Timms (WestEd Senior Research Associate) and the PT3 Project Manager and became familiar with the procedures for using instrument and the items on the instrument. This initial orientation included using the instrument to evaluate videos of teachers teaching. In phase two, the observers went into the field to collect data with the instrument. After field observations were conducted, the three observers met to compare their results and resolve differences. In phase three, the observers conducted several more field trials and their results were compared. The observers were found to be in substantial agreement and the formal data collection began. One observer conducted all of the AZCOTT observations and two observers conducted all of the beginning teacher observations. Any occasional difference between the beginning teacher observers was resolved through a discussion following each observation and the pair submitted one completed form for each observation.

The AZCOTT observer and one of the beginning teacher observers together conducted periodic observations during the observation year to make sure they were consistent in their observations and marking of the form. Only a few minor differences between them in marking of the categories were noted.

The selected participants were contacted to schedule an observation time. They were told that we were interested in seeing them teach a lesson that utilized technology of some manner. Each of the 18 AZCOTT and 28 beginning teachers were observed teaching on one occasion.

RESULTS

DATA ANALYSIS

Observations for all subcategories were recorded at three-minute intervals. For each subcategory the "Proportion of Time Observed" was computed. For example, if 7 of 13 of the three minute interval observations recorded students using spreadsheets technology, "Proportion of Time Observed" for that subcategory would be 7/13 or .54. The possible results range from 1.00, indicating that the technology in question was being used during 100% of the observation, to 0.00, indicating that the technology was not observed at any time. All the data were entered into SPSS. Mean scores and standard deviations for the four categories of technology use were computed by group (see Table 1).

STUDENT USE OF TECHNOLOGY

Inspection of the means in Table 1 reveals that two of the four uses of technology under investigation appeared at extremely low levels. Inspection of frequency tables further revealed that the use of communication tools was observed in only 1 out of 18 expert classrooms and in 0 out of 28 novice classrooms. Similarly, the use of subject specific tools was observed only in 2 out of 18 expert classrooms and 2 out of 28 novice classrooms. Because of the low occurrence of those two categories, and in order to fulfill the assumption that the covariance matrices of the dependent variable are equal across groups, they were not included in the following analyses. Similar adjustments were made in subsequent analyses for the same reason.

Table 1. Means and Standard Deviations of the Proportions of Time that the Four General Categories of Technology Use were Observed

	Experienced *n*=18		Novice *n*=28	
Category of Technology Use	*M*	*SD*	*M*	*SD*
Student Use of Research Tools	0.34	0.39	0.08	0.24
Student Use of Productivity Tools	0.54	0.30	0.27	0.38
Student Use of Communication Tools	0.03	0.13	0.00	0.00
Student Use of Subject Specific Programs	0.02	0.08	0.02	0.08

Because of the unequal sample sizes (18 compared to 28), Type III sums of squares were used in computing significance. This is in accordance with Method 1 as described by Tabachnick and Fidell (2007, p. 217-218). Although this is the most conservative method and even though the sample size was small, our multivariate analyses of variance had estimates of power greater than .80.

One-way multivariate analysis of variance (MANOVA) was conducted to determine the effect of group membership (expert, novice) on the remaining two categories of student technology use (productivity and research). Box's *M* (6.574) was non-significant with an *F* of 2.075 and $p < .101$. Significant differences were found between the two groups on the dependent measures, Wilks' Lambda = .78, F (2, 43) = 6.104, $p < .01$. The effect size (η^2 (eta-squared)) based on the Wilks' Lambda was .22.

Analyses of variance (ANOVA) on the dependent variables were conducted as follow-up tests to the MANOVA. The ANOVAs on productivity tools (F (1, 44)=5.58, $p <$. 05, η^2 = .11) and on research tools (F (1, 44)=7.66, $p<$. 01, η^2= .13) were both significant.

Productivity tools. To further understand the differences in student use of productivity tools the means of each of the eight specific uses were computed (see Table 2). Of the eight specific productivity tools investigated (Graphics/Organizers, Authoring, Hardware, Presentation, Word Processing, Data Base, Web Authoring, and Spreadsheet) only three (word processing, presentation, and spreadsheet) had means for both groups greater than zero. Only those three are included in the following analyses. A one-way multivariate analysis of variance (MANOVA) was conducted to determine the effect of group membership (expert, novice) on three viable categories of productivity technology use (word processing, presentation, and spreadsheet). Box's *M* (9.257) was non-significant with an *F* of 1.42 and $p < .203$. No significant differences were found between the two groups on the dependent measures, Wilks' Lambda = .97, F (3, 42) = .416, $p < .74$.

Table 2. Means and Standard Deviations of the Proportions of Time the Use of the Eight Specific Productivity Tools Were Observed

	Experienced *n*=18		Novice *n*=28	
Specific Productivity Tool	*M*	*SD*	*M*	*SD*
Graphics/Organizers	0.22	0.34	0.00	0.00
Authoring Software	0.14	0.33	0.00	0.00
Hardware	0.07	0.19	0.00	0.00
Presentation Software	0.12	0.30	0.06	0.19
Word Processing Software	0.18	0.36	0.14	0.31
Data Base Software	0.00	0.00	0.00	0.00
Web Authoring Software	0.00	0.00	0.00	0.00
Spreadsheet	0.11	0.28	0.08	0.24

Research tools. Student use of research tools targeted five specific areas: Internet Search Engines, Teacher's Web Sites, Internet Web Sites, Library e-catalogs, and CD ROMs. Table 3 contains the means and standard deviations on the dependent variables for the two groups. As seen in Table 3 only two (Internet Search Engines and Internet Web Sites) of the five categories were observed in both expert and novice classrooms. A one-way multivariate analysis of variance (MANOVA) was conducted to determine the effect of group membership (expert, novice) on those two categories of research tools.
Box's *M* (13.39) was significant with an *F* of 4.23 and $p < .01$ indicating that the covariance matrices of the dependent variable were not equal across groups, therefore the results of the analysis were discarded.

Data were also viewed in terms of the proportion of the time students were observed using technology of any kind during the observations. This overall category of student technology use indicates the proportion of time students were observed using any of the four categories of technology. The means and standard deviations for this overall category for expert and novice teachers were .66 (.34) and .35 (.34), respectively. Students of expert teachers were using technology about 66 percent of the observed time and students of novice teachers were using technology about 35 percent of the observed time. One way ANOVA on this variable (F (1, 44)=6.89, p<.02, η^2 = .14) was significant. In addition, it was noticed that the students were observed using more than one type of technology, especially combinations of productivity tools and/or research tools. Inspection of the data enabled the classification of teachers into one of two groups, those whose students used more than one type of technology at the same time during the observations and those that did not. A 2 X 2 chi-square test of independence for experience level of teacher (expert vs. novice) and level of use (less than two tools used vs. two or more tools used) was significant with a Pearson Chi Square value was 15.74 with a p < .001. The students of the experienced teachers were significantly more likely to use more than one technology during an observation. Students of 11 of the 18 (61 percent) experienced teachers used more that one productivity and/or research tool during the observations compared to only 2 of the 28 (7 percent) beginning teachers.

Table 3. Means and Standard Deviations of the Proportions of Time the Student Use of Specific Research Tools was Observed

	Experienced *n*=18		Novice *n*=28	
Specific Use of Research Tools	*M*	*SD*	*M*	*SD*
Internet Search Engines *	0.23	0.34	0.04	0.19
Teacher's Web Site **	0.07	0.18	0.00	0.00
Internet Web Sites	0.13	0.27	0.04	0.16
Library e-catalogs	0.00	0.00	0.00	0.00
CD ROMs	0.00	0.00	0.00	0.00

OBSERVATIONS IN ONE-TO-ONE ENVIRONMENTS

To control for access to computers, the authors analyzed the data when observations of both beginning and experienced teachers in one-to-one computing environments. In regard to the 15 (6 expert, 9 novice) teachers who were observed in computer labs, a variable was created that equaled the number of productivity tools plus research tools that were used by students during the observations. A one-way ANOVA was conducted to determine the effect of group membership (expert, novice) on that variable. A significant difference was found between the two groups on the dependent measure, F (1, 13) = 5.72, p < .05 with means and standard deviation for experts and novices of 2.33 (1.50) and 1.11 (1.12), respectively. The effect size (η^2) was .31. The analysis on the other variables revealed no differences.

DISCUSSION

Across important indicators of technology integration (such as use of productivity tools and use of technology to conduct research), students' uses of these technologies was greater in the experienced than beginning teachers classrooms. In the experienced teachers' classrooms, students used productivity tools twice as much and research tools four times as much as in the beginning teachers' classrooms. The specific productivity tools that were used more included graphic organizers (e.g., Inspiration), authoring software (e.g., Hyper Studio), and hardware (e.g., digital cameras). From this study a picture of the integration of technology in beginning and experienced teachers' classrooms begins to emerge. We found that experienced teachers' classrooms used a wider variety of technologies to accomplish a project. For example, during a single observation setting some students would be using the Internet for research, others would be preparing a PowerPoint based on the research data, and yet others taking digital pictures for the same project. Students would also move between tools, for example, a student might select a graphic from the Internet and insert it into a PowerPoint document.

By contrast, in a single observation in a beginning classroom, we might see all of the students using word processing to type the final draft of a paper. This pattern of multiple uses of technology by accomplished users is consistent with the picture painted by of Sheingold and Hadley (1990). However, the multiple types of technology reported in their study include use of specific subject tutorial and drill programs as well as tools such as word processing. In this study we saw multiple tool uses of technology by the students in experienced teachers' classes. It should be noted that in the experienced teachers' classes we found a larger total amount of students' time devoted to technology use as well as multiple uses during the same period observed.

Although the number of observations was reduced when the data analysis was limited to situations in which both groups had one-to-one access to technology, significant differences were found for the number of productivity tools plus research tools that were used by students during the observations. We believe that multiple uses of technology by students is an important distinction between the classrooms of beginning and experienced teachers. Further, the trend of technology use with the whole group was mirrored in the one-to-one comparisons.

Other differences with earlier studies were also evident. In this study it is interesting to note that for beginner teachers' classrooms, word processing was the most used tool and for experienced classrooms, the second most used tool. Experienced classrooms used word processing more than the beginners, but the differences were not significant. The pattern of substantial use of word processing for accomplished users is consistent with the data from earlier studies, but in the studies by Sheingold and Hadley (1990) and Becker and Ravitz (2001) accomplished teachers also used word processing more than beginning teachers. In the present study, one possible explanation for the lack of significant difference may be that the beginning teacher felt as comfortable with word processing as the experienced teachers. Also differences may not be evident in this study because both groups of teachers may have felt that writing with a word processor is compatible with their pedagogical beliefs, and closely connected to the curriculum; thus, this is an innovation that deviates less from the status quo (Zhao et al, 2002). That is, both beginning and experienced teachers may have seen a direct link between word processing and standards-based curriculum and have had sufficient technology skills to use word processing for language arts. This same level of technology skill and curriculum alignment may not be present for other technology tools.

It is also interesting to note that communication tools such as email were not seen in either group. Although nearly all schools have Internet access, providing individual emails accounts for all students is far more involved. It is relatively easy to provide students with web sites for research, but not as easy to provide school email accounts with individual IDs and passwords. Further, subject specific programs were not used very often in either group. This contrasts with the findings of Sheingold and Hadley (1990) who found that instructional tutorial software was used by 24% and drill and practice software by 37% of accomplished teachers.

Overall, experienced classrooms used on-line research more than the beginning classrooms. The specific research tools accounting for the differences were launch pages or another teacher web site with web links for students to use to complete an assignment and search engines (and key words) to locate resources. Neither group used CD-ROMs (e.g., Encarta) or library electronic catalogs.

What accounts for the differences between experienced and beginning teachers' classroom student uses of technology? We speculate that teaching experience may be a reasonable explanation. Palacio-Cayetano et al. (2002) found that experienced teachers made more effective decisions in regard to key technology integration and implementation principles. These researchers concluded that although both groups of teachers had similar technology skills, that teaching experience is a significant influence on the quality of technology integration. The nature of this expertise deserves further study. Teaching expertise seems to develop after years of experience, is in a narrow field and is bound to the context of the classroom. Several of Ropo's (2004) observations about expert teachers may help explain our observations. For example, he found, "Experts have automatic ways of reacting to frequently recurring situations" (p. 165).

Within the context of technology integration, experienced teachers may have developed routines for managing student use of computers more efficiently, e.g., distributing and collecting laptops. Use of these routines may minimize the disruption and difficulty of having students use computers. Also, Ropo found that, "Compared to novices, experts are more sensitive to individual students in class situations and the characteristics of task situations" (p. 166). In the elementary classroom, experienced teachers may provided necessary scaffolding to insure successful use on more complex projects and may have been more adept at constructing computer tasks to fit student skills and abilities, Finally, he found that "Experts are faster and more accurate in their observations than novices" (p. 167). Experienced teachers might recognize common technical problems as students begin to report them and take quick action to deal with them. For example, a teacher may note that two student groups report that they are not able to access a web site because it is down and the teacher announces to the class an alternate site to accomplish the same task. A beginning teacher may not recognize and diagnose the problem so quickly and thus be unable to accomplish as much. Thus, we recommend further study on the added demands of classroom use of technology by students in light of the characteristics of expert teachers.

Meskill et al. (2002) found that learning to use technology in a preservice teacher education class is not as compelling as learning to use technology as you teach and implement in the classroom. Teaching experience seems to matter.

DIRECT OBSERVATION

The *ITOI* provided a mechanism to conduct direct observation of the level and nature of technology use in classrooms. Data collected targeted four general categories of technology use. Each of the general categories was further delineated with subcategories. The subcategories enabled the observer to record the specific types of technology being used at any given time interval. The instrument also allowed the observer to record multiple uses of technology occurring simultaneously. The time sampling process allowed the observational data to be easily quantified and analyzed and provided a picture not only of what technology was being used but also the amount of time it was used during the lesson. The instrument appears to be a useful, authentic method of data collection and that it has obvious advantages over self-report methods. However, observations are time-intensive and costly to plan and implement.

LIMITATIONS

We attempted to control for the number of computers in the classrooms of beginning and experienced teachers by looking at one-to-one environments for a portion of the observations. Limiting the data analysis to these 15 classrooms reduced the impact of the study. We would recommend that the study be replicated in beginning and experienced teacher's classroom that had the same number of computers in the classrooms and same access to labs in their schools.

Further we would recommend that the complexity of the projects/assignments that students are doing should be examined. It is reasonable to speculate that an added component of technology integration should be the level of thinking that students engage in and/or the difficulty of the problems or projects they tackle. The question then is whether the technology tools are tools for problem solving. Does the technology help students to solve ordinary problems more quickly and easily or does the technology allow students to solve problems that one could not solve without the technology?

CONCLUSIONS AND RECCOMMENDATIONS

Initially, we speculated that the new generation of teachers would be members of the digital generation, i.e., digital natives rather than digital immigrants. Thus, the differences between the classrooms of beginning and experienced teachers might not be observable. On the contrary, this study found important differences between beginning and experienced teachers in the student use of some technologies in their classrooms. Future research should ascertain whether these differences are do to general teaching skills, e.g., planning, decision-making, and a focus on student learning, or whether specific technology training is more useful.

This study also demonstrates that classroom observation can provide a source of rich data to better understand technology use in the classroom. The classroom observation instrument appears to allow educators to differentiate between beginning and experienced teachers who are using technology in their classrooms. However, the cost of direct observation in time and effort must be weighed. We also believe that further research should be conducted to determine the correlation between findings based on teacher self-report (questionnaires) and trained outside observers. If the outcomes were similar, it would be advantageous to pursue self-report data. If the outcomes were not similar, the added cost of direct observation might be justified.

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