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Effects of Long-term Professional Development Training in Technology Integration on Teacher and Student Performance

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Abstract—*The four primary questions addressed by the evaluation were: 1) Does the AZCOTT program influence the frequency of digital technology activities that teachers use with their students and that students perform in the classroom? 2) Does the program influence student performance of computer skills? 3) Does the program influence student self-reports of their technology skills? and 4) Does the program influence student self-reports of their use of technology for classroom activities? Also, investigated were the students' ability to select appropriate software tools for given tasks and teacher attitudes toward the AZCOTT program.*

Keywords— long-term professional development, technology integration, teacher and student performance

1 Introduction

The Arizona Classrooms of Tomorrow Today (AZCOTT) program was a twelve-month graduate level professional development program designed to aid Grade 3-8 teachers with infusing technology into their instruction and to support student achievement. Originally a Preparing Tomorrow's Teachers to Use Technology (PT3) grant from the U.S. Department of Education funded the AZCOTT program, a partnership between five suburban school districts and one university in the southwestern United States. An Arizona Board of Regents Improving Teacher Quality Grant provided funding for the evaluation year of 2003-2004.

The AZCOTT Advisory Board requested an evaluation of the effectiveness of the program to enable them to make data-driven decisions regarding future funding and expansion of the program. Over the last few years, billions of dollars have been spent on educational technology and related professional development across the nation ("Technology Counts", 2004), it is then reasonable to examine the return on that investment. This study was designed to examine the technology skills and use of AZCOTT teachers and their students and a comparison group of Non-AZCOTT teachers and students. Many professional development program evaluations analyze the types of activities teachers plan (Becker and Ravitz, 2001) and teacher attitudes (Christensen, 2002). In addition to these two data types, this evaluation also examined student performance data.

The Arizona Classrooms of Tomorrow Today professional development program had two main components: a long-term professional development program and increased access to technology for teachers and students. A team of teachers from each of the five partner districts, 17 teachers total, participated in 60 hours of professional development over 13 months. In its publication of standards for professional development, the National Staff Development Council (2001) asserts that long-term/sustained professional development programs are necessary for effective learning to take place. The focus of the program was on the acquisition and integration of technology integration strategies into standards-based instructional units and on increasing technology skills. Each school district increased the access AZCOTT teachers and their students had to computers by purchasing new equipment, redistributing existing equipment, or providing increased computer lab access. The

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professional development sessions were conducted on 13 Saturdays between May 2003 and May 2004. All sessions were held in a computer lab at the partner university.

The curriculum addressed the National Educational Technology Standards for Teachers (NETS-T, 2000) and the Arizona Technology Education Standards (Arizona Department of Education, 2000). The curriculum focused on developing standards-based instructional units that integrated technology into both teaching and learning activities, supporting learners through the use of graphic organizer creation software (e.g. Inspiration®), identifying Internet resources, and implementing technology integration strategies. The 60 hours consisted of 45 classroom hours from Technology Integration in the Classroom taught by the partner university and an additional 15 classroom hours addressing project-based learning and the use of video to document classroom practice.

Support materials and resources included $80 per AZCOTT teacher to purchase instructional materials to support the implementation of the program. A yearlong subscription to the online resource site TaskStream© was provided for creating and publishing instructional units. Each teacher received a copy of Teaching with Technology: Creating Student-Centered Classrooms and of National Educational Technology Standards for Students: Connecting Curriculum and Technology. To expand the AZCOTT teachers' exposure to technology integration strategies, the registration fees for two state educational technology conferences were also paid. The increased access to technology component of the AZCOTT program was deemed essential since teachers often state that if they had more access to technology, they would integrate it better into their instruction (Kopcha, 2004). Strategies employed by AZCOTT partner districts for increasing teacher and student access to computers included: 1) ten to 20 laptop computers were placed on a mobile cart with wireless connectivity to the Internet; 2) the number of desktop computers in a classroom was increased by five, and 3) the amount of computer lab time allotted to AZCOTT teachers was increased. Some districts and schools provided additional peripheral equipment including LCD projectors, digital cameras, digital video cameras, and printers. The sustained professional development training design is critical if the increased student access to computers is to reach its full potential in the classroom (Sandholtz, Ringstaff, & Dwyer, 1997).

2 Method

2.1 Participants

Participants were 32 Grade 3-8 teachers and approximately 800 students from five school districts in the southwestern United States. Four of the five districts had different teachers participate in the AZCOTT program during the 2002-2003 school year. Free or reduced lunch percentages ranged from 38% to 89% and minority populations ranged from 20% to 80%. The participants were divided into two groups, those participating in the AZCOTT program (AZCOTT teachers and students) and a comparison group (Non-AZCOTT teachers and students). The comparison group was selected prior to the study from within the same five partner school districts to represent the same grade levels and similar demographic characteristics. Data collected at the beginning of the study indicated very similar beginning-of-study technology skills and use between the AZCOTT and Non-AZCOTT teachers.

Each of the two teacher groups included three teachers from 3rd grade, five from 4th grade, four from 6th grade, three from 7th grade, and two from 8th grade. The AZCOTT teacher teams volunteered to participate in the program as a team. The Non-AZCOTT teachers were asked to participate in the evaluation by their site administrator.

2.2 Materials

AZCOTT teachers and Non-AZCOTT teachers had access to "normal instructional materials" and technological resources provided by the districts. Each AZCOTT teacher received the materials developed for Educational Media and Computers 598 taught at the partner university, a copy of Teaching with Technology: Creating Student-Centered Classrooms and National Educational Technology Standards for Students: Connecting Curriculum and Technology, and an increase in access to computers for their students through one of the three strategies described above.

2.3 Procedures

The AZCOTT program operated without modification during the 2003-2004 school year. Each AZCOTT teacher participated in the 60 hours of professional development training and completed the assignments. Both AZCOTT and Non-AZCOTT teachers participated in other professional development opportunities provided by the district or other entities.

2.4 Evaluation Measures

The primary evaluation measures used in this study were: 1) Teacher Technology Use Questionnaire, 2) Student Technology Skills Performance Assessment, 3) Student Technology Skills Questionnaire, 4) Student Technology Activities Survey, 5) Teacher Program Evaluation Survey, and 6) Teacher Interviews. The Teacher Technology Use Questionnaire was administered to the AZCOTT teachers and Non-AZCOTT teachers in May 2004. The questionnaire addressed the amount of time a teacher used a computer for planning and instruction during the school year, the types of professional tasks performed on the computer, the amount of time their students used computers, and the types of technology activities participated in by their students. The Student Technology Skills Performance Assessment was administered in May 2004. Ten students were randomly selected from each participating teacher's classroom to complete the assessment. The assessment consisted of asking students to perform 18 steps required to produce and modify a word processing document. The skills needed for this performance were selected from the Arizona Technology Education Standards for grades 3-8 (Arizona Department of Education, 2000). A pilot of the assessment was conducted with 25 fourth graders and some wording was modified to increase clarity. The assessment was completed in a computer lab and printed as the final step. No explanations of the steps were provided to the students. The assessments were scored on a 1-0 basis, 1 indicating that the step was performed correctly on the student's document and 0 indicating that it was not. All performance assessments were scored by the evaluator without knowledge of the student's group.

AZCOTT and Non-AZCOTT students completed the Student Technology Skills Questionnaire in May 2004. The questionnaire addressed how well they could perform a total of 21 different tasks on the computer. In addition, AZCOTT and Non-AZCOTT students completed a Student Technology Activities Survey in May 2004. The survey addressed how frequently they performed 15 different tasks on the computer during the past school year.

All 17 AZCOTT teachers completed a Teacher Program Evaluation Survey at the end of the last professional development session in May 2004. The 20 items addressed the overall effectiveness of the AZCOTT program, the program's impact on teaching and learning, the support provided to the teachers, unexpected outcomes, and the program's most and least effective elements.

Two AZCOTT teachers from each of the five participating districts were randomly selected to be interviewed. The interviews occurred either in person or by telephone. The interview protocol consisted of five open-ended items. The interviews averaged about 15 minutes in length.

3 Result & Discussion

The results are reported in this section for AZCOTT and Non-AZCOTT teacher reports of their use and student use of technology and related activities, the performance assessment of students on computerrelated skills, student self-reports of their computer skills, and student self-reports of their computer activities in the classroom. Student selection of appropriate software tools and teacher attitudes towards the AZCOTT program are also reported.

3.1 Teacher Reports of Teacher and Student Technology Use

Data from the Spring 2004 Teacher Technology Use Questionnaire are reported in Table 1. The table reveals that nine of the 17 AZCOTT teachers, but only two of the 15 Non-AZCOTT teachers, reported using computers more than 60 minutes a week to deliver instruction. Similarly, ten AZCOTT teachers, but only two Non-AZCOTT teachers reported that their students use computers

more than 60 minutes a week in the classroom. Results were quite similar for the AZCOTT and Non-AZCOTT teachers on the six professional tasks listed in Table 1, with two exceptions. Fifteen of the 17 AZCOTT teachers, but only eight of the 15 Non- AZCOTT teachers, reported using computers to make student handouts and 13 AZCOTT teachers, compared to eight Non-AZCOTT teachers, reported using the computer at least once a week to get information from the Internet for lessons. AZCOTT teachers also reported their students used computers for more time than Non-AZCOTT teachers for each of the seven student activities in Table 1. The largest differences in frequencies were for "Searching for information" (13 of the 17 AZCOTT teachers reported once a week or more, but only one of 15 Non-AZCOTT teachers), "Producing multimedia presentations" (7 AZCOTT teachers reported once a week or more, but only one Non-AZCOTT teacher).

Table 1. Spring 2004 AZCOTT and Non-AZCOTT Teacher Survey Frequencies AZCOTT N=17 Non-AZCOTT N=15

Item	***AZCOTT***		***Non-AZCOTT***	
	60+min/wk	*< 60 min/wk*	*60+min/wk*	*< 60 min/wk*
Minutes per week teachers use computers to deliver instruction	9	8	2	13
How often during a week do you use computers for these tasks?	about once/wk	< once/wk	about once/wk	< once/wk
Record or calculate student grades	16	1	12	3
Make handouts for students	15	2	7	8
Write lesson plans	17	0	15	0
Get information from the Internet for lessons	13	4	8	7
Exchange files with other teachers electronically	4	13	1	14
Participate in discussion boards, listservs, etc	16	1	13	2
Minutes per week students use computers in the classroom	60+min/wk	< 60 min/wk	60+min/wk	< min/wk
How many minutes per week do your students spend using computers for these types of activities?	30+min/wk	< 30 min/wk	30+min/wk	< 60 min/wk
Composing (no paper involved)	7	10	4	11
Publishing written work (drafted on paper)	9	8	6	9
Communicating	2	15	1	14
Searching for information	13	4	1	14
Producing multimedia presentations	7	10	1	14
Organizing information/planning	4	13	0	15
Practicing computer skills	7	10	2	13

3.2 Assessment of Student Performance

The 18 steps of the Student Technology Skills Performance Assessment were ordered based on predicted difficulty using the Arizona Technology Education Standards as the guide. The skills from the Student Technology Skills Performance Assessment are shown in rank order by the performance of AZCOTT students in Table 2. The table reveals that the total mean scores across the 18 skills were 12.28 for the AZCOTT students and 10.29 for the Non-AZCOTT students. A one-way analysis of variance (ANOVA) conducted to test the overall mean scores of the AZCOTT and Non-AZCOTT students for significance revealed that the mean of the AZCOTT students was significantly higher than that of their Non-AZCOTT counterparts, $F(2,382) = 7.64$, $p<.001$.

Table 2. AZCOTT and Non-AZCOTT Student Performance Assessment Mean Scores By Skill AZCOTT N=195 Non-AZCOTT N=187

Skill	AZCOTT	Non-AZCOTT	Overall
Open your word processing program	1.00	.82	.91
Type the title of your story	.98	.98	.98
Make the title font size 36	.93	.83	.88
Type three sentences	.87	.82	.84
Type your grade level under the title	.79	.81	.80
Center the title	.77	.72	.75
Underline the title	.69	.68	.69
Add a piece of clipart to your document	.69	.51	.60
Make a copy of the clipart and paste it in your document	.55	.42	.49
Enter two blank lines between the title and three sentences	.55	.26	.41
Go on the Internet	.54	.44	.49
Go to the web site www.zoo.org	.54	.44	.49
Make one of the two clipart pictures bigger	.53	.38	.46
Copy a picture from the web site and paste it into your story	.52	.42	.47
Draw a smiley face	.44	.36	.40
Copy and paste web address into the document	.41	.28	.35
Copy and paste the web address under the picture	.33	.24	.28
Change the top margin to 2.0 inches	.14	.13	.13
Total Score	*12.28	10.29	11.13

18.0 = maximum score (1.0 per skill)
**AZCOTT students scored significantly higher (p<.001) than Non-AZCOTT students on the total score.*

Table 2 also reveals the AZCOTT students scored higher on 16 of the 18 individual skills in the performance with one additional skill being a tie. Non-AZCOTT students scored higher on only one skill. The individual skills in Table 2 are listed in rank-order by AZCOTT performance from highest to lowest. Comparison of the observed difficulty of these 18 skills with the order of difficulty in which they appear in the Arizona Technology Education Standards yielded a significant (p<.001) Spearman rank-order correlation of .92, indicating a very high correlation between their order of difficulty in the state standards and the order obtained by this study.

3.3 Student Reports of Technology Skills

The percentage of AZCOTT and Non-AZCOTT students choosing each response on the Student Technology Skills Questionnaire is reported in Table 3. The table reveals that the mean percentage score across the 21 skills for students who reported that they can do the skills well was 40% for the AZCOTT students and 28% for the Non-AZCOTT students. In contrast, the means for "Cannot do it" were 32% for the AZCOTT students and 45% for the Non-AZCOTT students. The AZCOTT students had a higher percentage score than the Non-AZCOTT students on all 21 items. They also scored 20% or more higher in the "Can do it well" category on seven items: write a story, letter or report; change font size and style; save a copy of a document with a new name; add clipart; change the size of a picture; copy pictures from the Internet into a document; and make a multimedia presentation.

Table 3. Spring 2004 AZCOTT and Non-AZCOTT Student Technology Skills Reports in Percentages
AZCOTT N=401 Non-AZCOTT N= 240

Item	AZCOTT			Non-AZCOTT		
	Can do it well	Can do it	Can not do it	Can do it well	Can do it	Can not do it
Write a story, letter or report	61					
Copy and paste test	48					
Change tabs and margins	31					
Change font size and style	75					
Save a copy of a document with a new name	68					
Add clipart	59					
Add a digital picture	25					
Change the size of a picture	67					
Copy picture from the Internet into a document	58					
Make spreadsheet	20					
Create a database	8					
Make a multimedia presentation	40					
Make a web	1					
Scan a picture and insert it into a document						
Download video onto a computer and edit it to make a movie						
Create graphics/picture						
Send email						
Add attachments						
Write a citation for an electronic source						
Use a digital camera						
Use a projector to present work						
Mean Percentage Score						

Data from the Student Technology Activities Survey reveal that of the 15 activities on the survey, an average of 39% of the AZCOTT students and 29% of the Non-AZCOTT students said they had done each activity often during the last school year. The five activities most commonly reported as being done “Often” versus “Sometimes” or “Never” by AZCOTT students are: “Researched a topic on the Internet” (62%), “Learned math” (52%), “Worked with other students to create projects” (51%), “Typed or published a paper” (48%), and “Learned language arts” (48%). The five activities most commonly reported as being done “Often” versus “Sometimes” or “Never” by Non-AZCOTT students are: “Took a test” (73%), “Learned math” (48%), “Worked with other students to create projects” (48%), “Practiced math skills” (40%), and “Researched a topic on the Internet” (30%). Student Selection of Appropriate Software Tools The last section of the Student Technology Activities Survey required students to select an appropriate software tool to use for a given task. For six of the seven tasks the percentage of AZCOTT students that selected the “Correct” tool versus the “Incorrect” or responded “I don’t know” was greater than for the Non- AZCOTT students. The one exception was “Draw a picture” with AZCOTT scoring 70% correct and Non- AZCOTT scoring 77% correct. The AZCOTT students scored 20% or higher more than the Non-AZCOTT students for four of the seven tasks. The tasks were: make an idea or concept map, write a story, create a presentation, and locate information. Teacher Attitudes Each of the AZCOTT teachers completed a 20-item Program Evaluation Survey consisting of 17 Likert scale items and three open ended items to assess teacher attitudes towards the program. The overall mean was 3.1 for the 17 Likert items on a scale from 4 (Strongly Agree) to 0 (Strongly Disagree). The most positive responses were for “My students react positively to technology-rich classroom activities.” (M = 3.9), “I use technology more with my students this year.” (M = 3.6), “It was helpful to use TaskStream® to create my instructional plans.” (M = 3.6), and “AZCOTT was a beneficial professional development experience.” (M = 3.5).

The least positive responses were for "Past AZCOTT teachers provided helpful feedback." (M = 1.8) and "AZCOTT was responsible for me taking on a leadership role this year" (M = 2.0). Responses to the open-ended items were collected and categorized by common themes. The most common response to "What were the most effective elements of the AZCOTT program?" was an increase in the use of technology due to of access to additional equipment, which was mentioned by 16 of the 17 AZCOTT teachers. The most frequent response (N=5) to "What were the least effective elements of the AZCOTT program" was "Creating two units of instruction," which was a requirement of the AZCOTT program. The teacher attitude data were supplemented by information obtained in individual interviews with ten AZCOTT teachers. In response to the question, "How did AZCOTT impact your teaching?" the teachers reported a variety of ways the program influenced their teaching. These included an increase in their efforts to integrate the technology into their teaching (N=8) and making their instruction more learner centered (N=5). The responses to "What do you wish you had learned?" revealed three themes: teachers wanted more technical training on hardware and software, more ideas for managing technology use, and more technology integration strategies. Discussion This evaluation was conducted to investigate the effect of the Arizona Classrooms of Tomorrow Today program on: 1) the types and frequency of digital technology activities that teachers use with their students and that students perform in the classroom, 2) student performance on a technology skills assessment measure, 3) student perceptions of their technology skills, and 4) student reports of their use of technology for classroom activities. Other factors examined included AZCOTT and Non-AZCOTT students' ability to select appropriate software for given tasks and teacher attitudes toward the AZCOTT program. The AZCOTT teachers reported using computers for more time per week to deliver instruction than Non-AZCOTT teachers. They also reported using computers to perform professional tasks more frequently than the Non-AZCOTT teachers. The teacher reports also indicated that AZCOTT students spent considerably more time using computers in the classroom than Non-AZCOTT students and that the time was distributed across a greater variety of activities. Thus, based on teacher reports the long-term professional development training and increase in technology access under the AZCOTT program had the desired effect of increasing both teacher use of technology for instructional purposes and student participation in technology-based instructional activities. Searching for information, producing multimedia presentations and practicing computer skills were the student activities for which the greatest differences were reported between AZCOTT and Non-AZCOTT students. The reported greater overall involvement of AZCOTT students with technology appears to be the most likely reason for their significantly better performance than Non-AZCOTT students on the performance measure. The overall mean of the AZCOTT students on this measure was approximately two points (12.28 to 10.29) higher than that of the Non-AZCOTT students, not a huge absolute difference but one that was highly significant statistically ($p<.001$). Furthermore, the fact that the AZCOTT students scored higher on 16 of the 18 skills comprising the performance measure indicates that their participation in the program produced quite a consistent effect across the individual skills. The self-report by AZCOTT and Non-AZCOTT students on their technology skills is consistent with the findings from both the teacher questionnaire and the performance assessment. AZCOTT students reported a higher ability to perform all 21 activities presented in Student Technology Skills Questionnaire than did the Non-AZCOTT students. Interestingly, two of the greatest differences favoring AZCOTT students were on "big picture" types of tasks: write a story, letter or report and make a multimedia presentation. The greater selfefficacy for computer use reflected in the AZCOTT students' reports may indicate they are more likely to choose to use computers at school or home. In turn, their greater current skills and self-efficacy could contribute to an increase in continuing motivation, defined as one freely returning to a task (Maehr, 1976), to use technology and an increase in performance in the future. Of course, higher ability to perform technology skills well as indicated by AZCOTT students on both the performance measure and self-the report of student technology skills, should be associated with greater participation in technology activities. That was indeed the case in the present study. An average of 39% of AZCOTT students, but only 29% of Non-AZCOTT students reported that they had participated often in the 15 computer-related activities in the survey. Further, the activity cited "often" most frequently by AZCOTT students was "researched a topic on the Internet" (62% to 30% for Non-AZCOTT students) while the activity cited as "Often" most frequently by Non-AZOTT students was "took a test" (73% to 45% for AZCOTT students). The AZCOTT professional development program stresses student-centered uses of technology, which may have been be a contributing factor to this difference in the most

common type of activity between AZCOTT and Non-AZCOTT students. The data on student selection of appropriate software tools were also supportive of the AZCOTT program. The fact that AZCOTT students scored 20% or higher more than Non-AZCOTT students on selecting the appropriate tools for making an idea or concept map, writing a story, creating a presentation, and locating information, was particularly impressive. The writing a story, creating a presentation, and locating information items are consistent with student self-reports showing 20% or greater differences between AZCOTT and Non- AZCOTT students in their self-reported technology skills for the first two items and in their frequent classroom activities for the "locating information" item. The AZCOTT program was a year-long experience that involved professional development training in the use of technology for instructional purposes as well as increased access to computers in the classroom. This evaluation yielded clear evidence that the teacher and student use of computers for instructional purposes, students' computer skills, and students' perceptions of their own self-efficacy with regard to computer use were higher for those that participated in the program versus the comparison group. These results, while not overpowering in their effect, were consistently positive across both teacher and student measures. The study indicates that a focused longer-term effort to increase the technology training of teachers and access to computers for their students can lead to improvements in their students' computer skills and in their use of computers to enhance their learning in the classroom.

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