DOCUMENT RESUME

ED 423 834 IR 019 055

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TITLE START (Student Trainers as Resource Technologists): An Alternative Approach to Technology Integration.

PUB DATE 1998-02-00

NOTE 13p.; In: Proceedings of Selected Research and Development Presentations at the National Convention of the Association for Educational Communications and Technology (AECT) Sponsored by the Research and Theory Division (20th, St. Louis, MO, February 18-22, 1998); see IR 019 040.

PUB TYPE Reports - Research (143) -- Speeches/Meeting Papers (150)

EDRS PRICE MF01/PC01 Plus Postage.

DESCRIPTORS *Attitude Change; *Computer Attitudes; *Computer Uses in Education; Educational Change; Educational Technology; Elementary Education; Instructional Effectiveness; Qualitative Research; School Culture; *Student Attitudes; Student Leadership; Student Surveys; *Teacher Attitudes; Teacher Surveys; Training; Tutors; Use Studies; Workshops

IDENTIFIERS Change Analysis; *Computer Use; *Technology Integration; Technology Utilization

ABSTRACT

This study investigates the effectiveness of integration efforts at an elementary school, where for the past 2 years, all students (grades 1-5) have received computer training at least one day per week from the media specialist, university personnel, and/or volunteers. A group of 18 students were trained as technology tutors in additional after school training sessions. The primary research question guiding the study was: "What impact does specialized student training have on teachers, students, and the school?" The researchers used qualitative methods to examine changes in the teachers', students', and school's use of and attitudes toward technology. Survey and interview data were collected from both student trainers and teachers, and workshop reflections were collected from the teachers. Results suggested that there was an increase in technology use, both professional and instructional, by teachers. Teachers reported increased comfort with technology as curriculum support. Students evidenced increased confidence, increased computer skills, and increased self-esteem. As a whole, the school culture changed to one that focused more on technology. The researchers propose that technology skills and pedagogical beliefs should be developed simultaneously, to help teachers integrate technology into the curriculum. (Contains 28 references.) (DLS)

START (Student Trainers as Resource Technologists): An Alternative Approach To Technology Integration

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The Office of Technology Assessment (OTA; 1995) recently reported that U. S. schools have over 5.8 million computers available for instruction. Over the past decade the number of students per computer has gone from 125 to less than 10 (Sandholtz, Ringstaff, & Dwyer, 1997). Although administrators have generally welcomed new technology into their schools, the introduction of computers into individual classrooms has created challenges for both experienced and inexperienced teachers (Becker, 1993). Many common barriers to technology integration have been identified including limited equipment, training, and time (Hadley & Sheingold, 1993; OTA, 1995; Ringstaff & Yocam, 1994), as well as teachers' resistance to change and their current pedagogical beliefs (Gilmore, 1995; Hancock & Betts, 1994; Hannafin & Savenye, 1993). Brickner (1995) suggested that these obstacles be categorized as first- or second-order barriers to change, defined as "the extrinsic and intrinsic factors that affect a teacher's innovation implementation efforts" (p. xvii). First-order barriers are extrinsic to teachers and include lack of access to computers, access to software, time to plan instruction, and technical and administrative support. Second-order barriers are intrinsic to teachers and include beliefs about teaching, beliefs about computers, organizational context, lack of instructional models, and unwillingness to change. While many of the first-order barriers may be eliminated through the procurement of additional resources and the use of traditional training methods, second-order barriers are more likely to persist, requiring different resources and training strategies.

According to Sorge, Russell, Mandell, & Brickner (1995), effective technology integration training should, among other things, provide assistance on "the process of implementing technology" (1995, p. 29, emphasis added). Although the implementation stage is generally recognized as being key to effective change efforts (Fullan & Hargreaves, 1992; Herriott & Gross, 1979), current methods of teacher training often fail to address this stage. In many instances, "technology staff development for teachers has been fragmented, not context-specific, and without ongoing support" (Meltzer & Sherman, 1997, p. 56).

A body of literature is accumulating that suggests that changes in methods of staff development may help alleviate second-order barriers to computer integration (Ringstaff, Sandholtz & Dwyer, 1991; Ringstaff & Yocam, 1994; Ritchie & Wiburg, 1994). A small part of this literature advocates the use of students as an integral part of the technology training process. Not only can the students learn computer skills alongside their teachers, but they can provide on-going technical and emotional support as the teacher begins the implementation process within her curriculum. The Apple Classroom of Tomorrow (ACOT) project illustrates how using student technology expertise in the classroom may effectively address implementation barriers. For example, Ringstaff et al. (1991) stated that "while many teachers at first questioned the value of using students as teachers and wondered how it would affect learning, teachers soon realized that the benefits of this role shift went far beyond saving them time" (p. 12). Teachers saw change not only within their students but within themselves. Teachers often took the role of facilitators, while students played the role of experts (Ringstaff & Yocam, 1994). As the teachers became more confident with this pedagogical shift, learning to integrate technology became more relevant. "Only classroom practice (i.e., working with children) provides relevance and purpose to access skills and information and, therefore, has the potential for long-term changes in teacher behaviors" (Gilmore, 1995, p. 254).

Background and Purpose of the Study

In the fall of 1995, faculty and graduate students at a midwestern university initiated an alternative approach to teacher technology development at a local elementary school (referred to here as Midland Elementary).

For the past two years, all students (grades 1-5) have received computer training at least one day a week from the media specialist, university personnel, and/or volunteers. An additional after-school training program was initiated in the fall of 1996 to train a small group of students to serve as technology tutors (named by students as the Midland Computer Masters or "MCMs"). This group of 18 students met one hour/week to receive specialized training on computer hardware and software. The purpose of this ongoing project is threefold: 1) to develop a successful technology program in an elementary school setting, 2) to target students as technology leaders as a way to increase self-esteem, leadership, technology, and collaborative skills, and 3) to encourage the use of available technologies among teachers by providing readily available "experts."

The current study represents the second in a series of year long studies that have taken place at the school, investigating the effectiveness of our integration efforts. Results from the first year were used to inform planning, implementation, and evaluation strategies used in the current study. The primary research question that guided our study was, *"What impact does specialized student training have on teachers, students, and the school?"* Specifically, we asked:

- What changes occur in teachers' uses of technology as well as their reasons for use?
- What changes occur in students' confidence with technology, basic computer skills, and self-esteem?
- What changes occur in the school's technology culture, including use of student trainers?

Methods

We used qualitative methods to examine changes in the teachers,' students,' and school's use of technology. We examined teachers' and students' uses at the beginning of the year, prior to implementing our after-school training program, then examined technology use at the end of the year to document the types of changes (if any) that had occurred. In addition, teachers' and students' attitudes toward technology use were assessed, as well as their perceptions of the changes that had occurred in themselves, their students/teachers, and/or the school. These perceptions were then compared to the researchers' perceptions of change.

Role of the Researchers

The researchers involved in this study included 1 faculty member, 5 graduate, and 2 undergraduate students from the local university. Three of the graduate students had been with the project since its inception; the faculty member and undergraduates joined at the start of the second year. Five Midland teachers and the librarian served as "co-chairs" during the second year, jointly overseeing, with a university team member, various components of the project (planning, implementation, funding, and research). Co-chairs met monthly to plan training and implementation strategies and to determine how to solve logistical and other problems.

Description of Site and Participants

Midland Elementary, a local Professional Development School (PDS), is one of 11 elementary schools in the corporation with a total enrollment of 281 students, representing approximately 201 families. The student body consists of a mixture of lower and middle class students, including 31 students with special needs. The participants in the study included all 13 teachers (2 teachers each in grades K-5 with an additional teacher in a multi-age primary classroom), 18 students selected as tutors, the librarian, and the principal. Table 1 summarizes demographic information for Midland staff participants (using pseudonyms).

At the time of the study, Midland's technology resources were limited. Each teacher had one Power Mac in his/her classroom. To facilitate student training during Tech Time (weekly 1/2 hour sessions for all students grades 1-5) and MCMs (after school training for 18 technology tutors), teachers had to roll their computers, on carts, to the library on Wednesday afternoons so they would be available for Tech Time on Thursdays and Fridays. Thus, computers were in the classrooms three days a week and in the library the other two.

Table 1. Demographics of Midland Staff Members.

Participant	Role/Grade	Years of Experience
Bea	Teacher/K	10
Chris	Teacher/1	4
Ethel	Teacher/3	40
Janet	Teacher/K	8
Janette	Teacher/MAP (1-2)	24
Julie	Teacher/2	5
Lana	Teacher/MAP (1-2)	30
Marlene	Teacher/5	30
Micelle	Teacher/MAI (3-5)	17
Molly	Teacher/MAI[b] (3-5)	25
Patty	Teacher/MAP[a] (1-2)	26
Polly	Teacher/MAI (3-5)	14
Stephan	Teacher/4	23
		Average =18 years
Nancy	Media Specialist	5
Deborah	Principal	10

Note. [a]Multi-age Primary. [b]Multi-age Intermediate

Procedures

In the fall of 1996, Midland classroom teachers in grades 3-5 were asked to refer students for the after-school technology program based on students' current computer skills (both high and low levels were included), ability to quickly learn computer skills, and ability to help others learn computer skills. Initially, 18 students were invited to participate. This included 5 third, 6 fourth, and 7 fifth graders and consisted of 10 girls and 8 boys. Ten of the students met in the school's library for an hour each week on Thursdays; the other 8 students met on Tuesdays in the central administration's Mac lab. Three second graders (a girl and 2 boys) joined the Tuesday group in the spring. Students learned about desktop management, word processing and drawing applications, HyperStudio stack development, and the Internet.

Data Collection

To investigate changes that occurred over the year, survey and interview data were collected from both student trainers and teachers in the fall and the spring.

Data sources—students

Harter's Self-Perception Profile (Harter, 1984) was administered to assess changes in student trainers' self-esteem. The 20 student trainers were interviewed to assess changing attitudes toward computer technology as well as toward the after-school program. Technology projects (e.g., word processed stories, HyperStudio stacks) indicated changes in technology skills and served as triangulation data.

Data sources—teachers

All 13 teachers completed an open-ended survey in the fall to assess current uses of, and attitudes toward, computer technology. Seven teachers were interviewed to gather additional data. Follow-up surveys were gathered and interviews conducted with 12 teachers, as well as the principal and media specialist, in the spring (the one non-responding teacher was retiring at the end of the year and was a non-computer user). Open-ended statements describing current technology use (referred to as "workshop reflections") were also collected at two technology in-services held during the year.

Data Analysis

The university research team worked collectively to analyze the data. Initially, each researcher took responsibility for analyzing one set of data, (e.g., student surveys), employing a constant comparative method of

analysis to identify tentative patterns in the data. After sharing early codings and themes, we exchanged data sets and performed similar analyses on a team member's data set. Regular meetings were held throughout the year to compare and synthesize emerging findings across data sources.

Interpretation of Results

Guided by the overarching research question, "What impact does specialized training have on teachers, students, and the school?" we examined changes that occurred in classroom teachers (amount and types of uses of technology, reasons for use), student trainers (confidence with technology, technology skills, and self-esteem), and the school (technology culture, use of student trainers). Data were collected from five sources (teacher and student interviews and surveys, and teacher workshop reflections) in the fall and spring so that changes in use could be assessed across time. We examined changes in teachers and students first, then drew on this information to describe changes that occurred at the school level.

Teacher Changes

Teachers' use of technology was reviewed both in terms of how (the purpose to which it was directed) and why technology was used (the supporting rationale).

Teacher Use--*How* Technology Was Used

Teacher use was classified into two main types: professional and instructional. *Professional* uses included teachers' use of the computer to communicate with parents through newsletters, to create instructional materials, and to locate and/or organize professional or instructional information. *Instructional* uses of the computer included any use in which students interacted with computer programs, either directly in the form of some type of CAI program, instructional game, or tool application (e.g., word processing, HyperStudio), or indirectly in which the teacher used a CD-ROM or laserdisc to present information to the students.

Professional uses of technology. In the fall, nine of the 13 teachers mentioned that they used the computer primarily for writing newsletters and creating instructional materials. Locating and organizing information via databases (n=1), CD-ROM resources (n=1), and by creating tables in Word (n= 5) were noted less frequently.

In the spring, these same, as well as additional, uses of the computer were reported by more teachers. Twelve teachers reported using the computer to write newsletters; 12 used it to create instructional materials; 4 reported using databases, and 6 used CD-ROM information resources. Additionally, 11 teachers were using the computer for some type of record keeping and 3 teachers noted the use of e-mail. Thus, more teachers were making use of more applications than noted in the fall. As Nancy, the media specialist pointed out, " The staff is using the computer much more. And more members of the staff."

However, it is important to remember that this data indicates the types of uses teachers made of the computer and not the amount of use. Survey data indicates that teachers' use increased slightly from an average of 2.4 hours a week to approximately 5.5 hours a week. In addition, teachers' ratings of comfort levels with computer applications, on a scale from 1 (not comfortable) to 4 (very comfortable), increased for word processing (from 3.3 to 3.9), yet showed little change for databases, spreadsheets, or graphics.

Instructional uses of technology. In the fall, ten of the 13 teachers mentioned some type of instructional use of the computer. Classroom uses revolved primarily around the use of prepackaged CAI programs and computer games (n=7), and these uses occurred most frequently within the context of learning centers (referred to here as stations). Five teachers mentioned using CD-ROMS or laserdiscs in instruction, 3 teachers noted students' use of word processing, and 3 teachers noted students' use of HyperStudio.

In the spring, there was only one teacher who did not mention using the computer for instructional purposes. Ten teachers mentioned using various CAI programs, nine teachers were noted as using instructional games, and six teachers were noted as using CD-ROM programs. Additionally, 11 teachers mentioned that their students were using word processing for creative writing, and seven teachers noted the use of HyperStudio for projects and reports. Six teachers noted that their students were using graphics applications to enhance their reports. A couple of teachers also noted that their students were occasionally using other applications, specifically the Internet, databases, and spreadsheets.

In comparison to the fall, instructional uses were more varied (additional applications were mentioned) and more common (more teachers were using more applications) in the spring. However the primary context for use continued to be that of a learning station. This finding from teacher interviews was supported by the principal's observation. When asked to describe how her staff was using technology, the principal described two primary types

of use: In a lot of classrooms, kind of the classic example of "if you get your work done you can have computer time." Others will use it as a station during discovery or center time.

Thus our results suggest that by the end of the 1997-98 school year the teachers had changed, to some extent, in terms of what they used, but not in terms of how that use was structured. Learning stations, or independent remedial or enrichment work, appeared to be the main types of uses of technology. These uses seemed to fit relatively easily into teachers' current practices and seemed to support the teachers' ideas about the type of instruction needed to reach their students. This finding is similar to that reported in the literature: teachers' initial uses of computers tend to be directed toward supporting traditional goals (Hadley & Sheingold, 1993; Marcinkiewicz, 1993). Becker (1991) suggested that this is true even for teachers with an abundance of equipment. Teachers favored traditional programs of instruction that were "not very different than what would be followed without the computer" (p. 8).

Teacher Use--*Why* Technology Was Used

Reasons for professional use. Teachers used technology because they perceived that it increased their efficiency, enhanced their professional image, and/or increased the appeal or effectiveness of their instruction. The following quotes exemplify these perceptions:

- *efficiency*: A computer is so much easier (than hand typing)--you type it, file it, and then pull it up later. You don't have to take so much time (Lana, fall).
- *professional image*: I like to do books for the kids, and the print is so much better than my handwriting. I think it makes things look neater, sharper, and more professional (Dea, spring).
- *appeal*: I create a lot of my own materials--if I'm going to make up math story problems I'll use the kids names . . . so I can make things closer to their interests (Julie, fall).
- *effectiveness*: We can pick a theme, or a topic in science, and we'll find pictures and short videos on the laserdisc to support the ideas, which is wonderful (Molly, spring).

Reasons for instructional use. We analyzed the reasons teachers gave for using technology in instruction and identified five main reasons for use: 1) to reward good behavior or effort, 2) to build and/or reinforce skills, 3) to enrich or enhance the current curriculum, 4) to expand (add more depth or related study to) the curriculum and 5) to change or transform the curriculum. Although none of the teachers actually described using technology to change the curriculum, this category was included based on the literature, as well as on our observation that some teachers seemed to be moving in this direction. The majority of uses that teachers described centered around the first three reasons. Each reason for use is exemplified below with a quote from one of the teachers:

- *Reward*: It's a good motivator to say, "I'll make sure you get to be first on the computer if you will just do this." I have one child who it works as a real good incentive for him because he really just flat out wants to refuse to work and so I can use the computer as an incentive (Julie, fall).
- *Reinforce*: Using the computer to expand on ideas helps kids understand and retain information, helps kids review skills (Patty, spring).
- *Enrich*: Technology integration means supporting my teaching and ideas and the program that I'm in. It's nice to be able to (use) the CD-ROMs and things that are already prepared. Some of them do a nice job of integrating ideas. It's nice sometimes to have something right on hand that you don't have to spend time developing (Michelle, spring).
- *Expand*: Technology integration means that all (students) can use the computer in a way where the technology, whatever it may be, in a way that helps foster a better learning experience or a more creative xperience (Nancy, spring).
- *Change*: Technology integration means using technology to develop the curriculum, to continually create new curriculum (Marlene, fall, 1997).

Teachers at Midland typically did not describe using technology to provide part of the "core" curriculum but rather to provide additional or more motivating ways for students to learn skills or topics that had already been introduced. Figure 1 summarizes our interpretation of each teacher's primary reason(s) for use based on interview and survey data, and also helps to illustrate where the school was, as a whole, in terms of use. We observed little change in teachers' reasons for use from fall to spring. Given that technology use is likely to represent, rather than shape, beliefs about teaching and learning, major change was not expected.

Figure 1. Teachers' primary reasons for using technology in the classroom.

Teacher/ Type of use	Reward/ Motivate	Reinforce/ Build Skills	Enrich/ Enhance	Expand/ Extend	Change/ Transform
Bea			XXX		
Chris		XXX			
Ethel	non-user				
Janet		XXX			
Janette			XXX		
Julie	XX	X			
Lana			XXX		
Marlene				XXX	
Michelle			XXX		
Molly			XXX		
Patty	X	XXX			
Polly			XXX		
Stephan			XX	X	
Nancy			XX	X	

We think of these five types of uses (e.g., reward, reinforce, enrich, expand, change) as being on a continuum with higher levels of integration on the right. Whereas a "reward" type of use can occur completely outside the curriculum, a "change" type of use leads to an evolving curriculum--one that is continually being invented as new opportunities and possibilities arise (Hooper & Reiber, 1995). In this study, most teachers emphasized only one type of use, although one teacher (Patty) frequently mentioned both motivational and enrichment uses, as noted by the extra X in the figure.

Summary

Based solely on the number of teachers who used the computer, and the number of ways they reported using it, our results suggest that there was an increase in technology use by teachers, for both professional and instructional purposes, from fall to spring. Yet these increases in use did not appear to be accompanied by any related shifts in instructional approaches or processes. Patty's quote illustrates how most teachers used technology to support current curricula:

> I like to see the technology brought in and related to what I'm doing. And I think it takes a well planned teacher to do that. I think I need to plan for how could this computer help me expand on this idea or how could the computer help get this scientific term ingrained in their little minds? How can tech help review this math skill that I have already taught them?

In general, the changes that teachers noted in themselves related to increases in comfort, confidence, and interest rather than to changes in teaching methods or classroom organization. As Molly explained in the fall: "As far as classroom processes, (they) haven't changed at all" and again in the spring, "Technology hasn't changed the way I teach. I look at technology as a support to the way I teach."

Student Changes

Differences between students' pre and post Self-Perception Profiles were not statistically significant (t = .029; $p > .05$), yet survey and interview data from both teachers and students provided evidence of change in students' confidence, technology skills, and self-esteem. Comments were classified as related to *confidence* if they referred to students' comfort with technology, with helping others with technology, and/or with a growing conviction of their technology skills. Comments were classified as related to increased technology *skills* if they referred to new tasks that students could complete on the computer. Comments were classified as related to *self-esteem* if they referred to children's increased sense of self-worth or pride in their accomplishments.

Increased Confidence

Students made many comments that reflected their growing confidence with technology. When asked the question "I used to (do something in regard to technology), but now I (do something else concerning technology)," nearly all of the students answered in a way that suggested an increase in both skills and confidence. For example, Anna remarked:

> I used to not go on computers and I used to think that computers were for the brainy kids and they weren't for me. And they were too hard for me. But now I know that computers can be fun sometimes and they aren't always hard and they aren't for brainy kids, they can also be for me too.

Ashley expressed a similar idea:

> I used to be like, "It's never gonna happen, I'm never gonna understand technology. Computers? Too hard." But now I'm like, "Computers? Easy. HyperStudio, Claris Works...They're just like the basics." They used to be really hard for me, but now they're really easy.

Students were generally not afraid to help when their teachers experienced difficulties with the computer, even if they were not certain how to fix the problem themselves. Tony, a third grader said, "...she goes 'Does anybody know how to turn the computer off?' and I go 'I'll try to.' So I tried it and it worked." Anna commented, "Sometimes the teachers get stuck on the computer and I'm like 'Well, maybe if you take it this way, it'll be able to work.' And then they try it and sometimes it works and sometimes it doesn't."

Students also liked being able to help the other students in their classrooms. Comments such as Erin's: "I like doing it (the MCM program) because I get to learn new things and then I can show it to other kids," and Danielle's: "...I'll help them. Sometimes I'll teach them new things like on databases and spreadsheets. I'll teach a little bit on the Quick Take camera. Just simple things like that" both illustrate the confidence students displayed when helping others.

Teachers also noted how students' confidence had grown. As Janette pointed out, "The children are fearless. They are not afraid to try things and they genuinely enjoy it (technology)." Stephan noted how "several students helped other students with computer skills." The principal indicated that she had observed increases in "students' comfort level in knowing some of the different software packages and how to use them."

Increased Computer Skills

Most likely, the increases in students' confidence were related to their growing skill levels. Students were certain that they learned a great deal as MCMs. When asked at the end of the year what they had learned, students made comments such as, "Everything. I never knew anything about a computer" (Shanea). Jason described a few of the specific skills he had learned, "I've learned lots of things like you can get into writing Claris Works, you can get a picture from up there, cut it, then go back into HyperStudio and if they don't have that same picture you can paste it on there and then you have a picture from Claris Works. I've just learned a lot of things." Laura also listed some of the specific skills she had learned: "...how to do some stuff like with the ZapShot camera and load it on to the computer. And we're starting to use the Internet and how to find things on the Internet." Similar comments were made by nearly all students interviewed.

Teachers also commented on the growing skill level of the students. Nancy explained, " We are seeing a lot more usage of the computers. As a whole the students are learning, understanding it better, the students know (more), than for the most part, the staff members."

Increased Self-Esteem

Although students did not make any direct comments about increases in self-esteem, we can infer this from the way they described their growing skills and confidence. When Anna stated how "technology is not just for brainy kids but for me too" she conveyed pride in what she had accomplished. When Ashley described how she "caught on pretty quickly" and how she "just gets it right" when she guesses what to do, she also expressed a sense

of pride. Nick described how he felt special because of his new skills: "I used to only do regular stuff on the computer that everybody knows but now I do more higher level technology stuff because I know more."

Teachers made a number of comments about how students, particularly their "at risk" or "difficult" students, had excelled in the technology program and had experienced increased self-esteem. For example, Marlene noted:

> Kids can be successful even if they have not been successful with the regular curriculum. (Technology) improves the self-concepts of all students, especially at risk students. . . I think we should continue the Tech program. The children enjoy it, they feel proud, they feel successful. One of my students goes to another classroom and helps another teacher, which makes him (work) better.

Molly described it this way:

> I've found that many of our kids who have a handicap are very successful on computers and it makes them very confident, happy, and proud. It's just really fun to watch them. In many cases those kids turn around and become helpers to students that you would assume would catch on immediately.

School Changes

The principal and the teachers perceived that the school, as a whole, had made some important changes in technology use. At the start of the study (fall of 1996), teachers were asked to describe the role that technology had played at Midland in the past. Many teachers described the limited role that technology had played to date. Others elaborated, indicating that the primary use of the computer had been in the form of drill and practice programs, instructional games, and "a little" word processing. In the spring, teachers made the following comparisons to describe their perceptions of how technology's role had changed:

> Patty: We used to use computers sporadically but now we have a plan.
> Julie: We used to have limited use, now we integrate with instruction.
> Lana: We used to (just) talk about it, but now we use it.
> Dea: We used to let the computer sit; now we have instructional programs on it for the kids.
> Marlene: We used to play games, now we enrich all areas of the curriculum.
> Polly: We used to view computers as reward for finishing work, now see them as more of a tool to assist students.
> Deborah: "We've probably grown 3, 4, 5 years this year, in comparison to past years."

These changes that the teachers and principal noted (in planning, frequency of use, and reasons for use) were perceived as contributing to a climate of change at Midland, with a focus on technology. As Marlene noted, "I think it (our technology focus) has helped to bring the staff together and we feel a commonality." The principal stated that the changes/growth at the school were due, not to specific factors, but to this change in culture, "It's not just the MCMs and Tech Friday. I think it's an entire package, a focus, a concerted effort, and also a breaking down of barriers. . . . I'm not sure what the catalyst was, but I think it's probably a brew that mixes."

As a whole, teachers in the school seemed to be making a conscious effort to include the computer in their curricula in whatever ways fit their teaching styles best--whether as a remedial or reward tool, or as part of an instructional center. Talking about, and working toward using the computer, had become a natural part of the school culture. This changing culture was also reflected in teachers' attitudes toward, and increased uses of, the MCMs as described in the next section.

Attitudes Toward and Use of Student Trainers (MCMs)

Teachers' responses to the MCM program were positive throughout the year. In the initial interview Patty commented, "I think the Tech program has had the biggest influence on our children's ability to use the computers." In the spring Michelle said, "I think what we're doing is really good. I'm hoping it will be something that over the next few years will really grow."

As the year progressed, teacher use of the MCMs increased. At the beginning of the year, teachers reported no use of the student helpers. By the end of the year, teachers indicated that the MCMs were being used by both

students and teachers. Janet reported, "I have an older student [a fifth grader] working with one of my kindergartners, teaching her HyperStudio." Julie, the 2nd grade teacher commented, "We used to rely on teachers to be experts, but now the MCMs are knowledgeable." One teacher described how she, herself, had used a student trainer:

> We had to bring (to the second inservice) something that we had done using it (HyperStudio). I hadn't done anything on it. I thought "Oh great, what am I going to do?" So I grabbed a 5th grader who is excellent in it. She was wonderful. I was absolutely amazed at her knowledge on it. I learned a lot from her and I think that's good that the kids see that we don't know everything and that must make them feel kind of good that they can help us out too. (ESL Teacher)

Teachers' positive attitudes toward the program may also have been enhanced as they began to see additional benefits of the Tech program. Student enthusiasm and computer expertise increased. Students also began solving technology related problems.

Perceptions of the Students

Based on teachers' comments, technology use at Midland had changed substantially during the year. However, teachers tended to perceive greater use (by both teachers and students) than students did. For example, one teacher stated, "My class uses computers, CD players, laser disc players, and ZapShot cameras throughout the curriculum," yet one of her students said: "The kids don't use that much technology anymore, other than games. For typing reports and stuff like that we don't really use the classroom computer. It just sits there most of the time." Similar comments were made by other students:

> We've used (computers) during my free time--which is hardly ever (Ashley).
> I don't ever use it for my school work. Once we did, but we don't do it anymore. We used to play on the computer at recess in the winter (Shanea).

It's not clear why students perceived different levels of use than the teachers. Maybe because students were so anxious to use the computers they thought that they never got to use them enough. Or maybe the teachers' perceptions/definitions of use were broader than the students. Whatever the reason, we realize that, in the future, we need to expand our data collection methods to include classroom observations. These will enable us to verify how often students and teachers are using the computers as well as how they are being used.

Perceptions of the Researchers

Teachers at Midland defined technology integration differently than the researchers. Whereas our definition was directed more toward "changing" the curriculum, teachers in this study typically defined technology integration as using technology "to present, reinforce, or motivate children to interact with the (current) curriculum." For example, a teacher who stated that she used technology to "enrich" the curriculum, elaborated by explaining that technology provided an additional way for her to present the curriculum to the students. Another teacher defined technology integration as "using technology to enhance what you are teaching; helping students learn what I need to teach them." In these cases, enrich meant providing students with more of the same curriculum as opposed to taking the students beyond what was currently prescribed to explore new topics or old topics in more depth and with greater involvement. "I'm not dependent upon the computer to teach them something but more (to) reinforce things that I've taught."

This approach to technology integration is consistent with how other teachers, in the literature, have described "getting started" with technology. Dwyer (1996) reported that when teachers started using technology in the ACOT classrooms there was, initially, very little change in classroom practice. However, as teachers gained confidence and skill with the technology, and as they witnessed changes in their students' motivation, performances, and interactions with each other, a shift occurred:

> Teachers' own growing prowess, coupled with observable changes in their students' work and forms of interaction, opened the staff to the possibilities of redefining how they went about providing opportunities

for students to learn. Technology was acknowledged as the catalyst for new perspectives and practices (p. 24).

Midland School has only recently embarked on the technology change process. The teachers' current approaches to use fit comfortably within their current levels of knowledge, skill, and confidence. However, as these continue to increase, and as students' confidence and skill also continue to grow, change may occur more rapidly.

Discussion

Our work with Midland School provides a mini-case study of the educational change process. Educational change has been noted as being a particularly slow process, especially when it comes to adopting new technologies (Cuban, 1986; 1990). The literature suggests that it takes 3-5 years for teachers to become "integrated" technology users (Hadley & Sheingold, 1993). Even with the extra effort and time contributed by Project START, we are not sure that we have expedited this relatively long process. What we seemed to have accomplished, however, was to heighten teachers' awareness of technology use, particularly for those who had shied away previously. By being present in the school, by constantly asking teachers, students, and staff to consider where they were and where they wanted to go with technology, we believe we helped increase the school's awareness of what was happening (and to some extent, what was possible) with technology and thus contributed to the establishment of a technology culture in the school.

Although Midland school did not move as far or as fast as we had hoped, the principal and teachers all perceived that major changes had occurred. The principal stated, "giant strides have been made." The changes that the teachers noted as having occurred at the school level (see p. 15) are cited in the literature as being critical during the early stages of integration: having a plan, initiating use, making use relevant, extending use to new areas, and reconceptualizing use as a tool rather than a reward (Hadley & Sheingold, 1993). Indeed, without these first steps, more innovative and challenging changes are unlikely to occur.

Midland teachers experienced many first-order barriers to computer integration including lack of computers, time, and experience, yet these barriers did not prevent them from becoming "keen on technology." In fact, Midland provides a good example of a how a school with few resources, but with a lot of teacher and student motivation, can jump-start the integration process. During the 1996-97 school year, Midland's culture assumed a strong technology flavor, which we attribute to many interrelated factors: increased student and teacher confidence and skill, use of student trainers, as well as the researchers' presence in the school.

Although teachers were quick to point out existing first-order barriers, they seemed unaware of second-order barriers operating in the process. Yet, in the researchers' view, teachers' existing instructional practices and their beliefs about the role of technology in the curriculum limited the extent to which technology was used to support meaningful learning.

So what happens now at Midland? Even though the literature suggests that technology use can prompt changes in teaching practices and beliefs that might not occur otherwise (Goldberg & Richards, 1995; OTA, 1995), we saw little evidence of these types of changes occurring at Midland. Teachers were not only content with what they had achieved, they were proud--they had made important changes; they had come a long way.

Before we decide how best to assist Midland during the next few years, we need to answer some difficult questions: Have Midland teachers achieved an effective level of technology integration? Should we be content with the gains that have been made? Should/Can we challenge these teachers to search for new uses, new conceptualizations of, and new visions for technology integration? (If so) How can we help teachers move beyond current uses, given their existing teaching practices and expectations for technology?

Although our work with the MCMs has provided Midland with on-going technical support through the use of student helpers, what seems needed now is a greater provision for instructional support. Based on the findings of this study, as well as numerous suggestions in the literature, we believe that this support should be in the form of helping teachers envision the kind of learning experiences they can create for students through technology-based learning activities and then providing the resources (technical, emotional, and instructional) needed to realize this vision. This includes giving teachers the time and support needed to observe exemplary models of classroom technology use, to reflect on and discuss their evolving ideas with mentors and peers, and to collaborate with others (students and teachers) on meaningful tasks as they try out their new ideas about teaching and learning with technology.

Conclusion

"Neither powerful technology nor good ideas are enough to improve education. Success in using computers in education will come only as a result of the intelligent and artful orchestration of many details in the classroom" (Walker, 1996, p. 102), the majority of which are determined by individual classroom teachers. Teachers, not technology, are the key to whether technology will be used appropriately and effectively in classrooms. Thus, efforts to integrate technology must focus on teachers, what they believe comprises good instruction and good learning, and how they put these beliefs into practice.

Rather than address technological or pedagogical needs separately, we propose that technology skills and pedagogical beliefs be developed simultaneously. This might be accomplished by embedding technology training within authentic activities that engage teachers in collaborative problem-solving tasks, relevant to their needs. In this way we can provide teachers with both a vision of what "teaching with technology" looks like, as well as a model of the type of learning experiences we are asking them to create for students.

Regardless of where teachers start in the integration process, whether unfamiliar with technology, student-centered pedagogy, or both, teachers will need to learn new skills related to any or all of the different elements involved in the integration process--technology, instructional design, classroom organization and management, and student assessment, to name a few. Furthermore, most teachers are likely to find themselves having to confront their established beliefs about instruction and their traditional roles as classroom teachers. It is imperative that we help teachers attend to all aspects of technology integration. Anything less, and our efforts are unlikely to result in sustained classroom implementation (David, 1996; Griest, 1996; Pea, 1997).

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