The Role of the Teacher in Scaffolding Children's Interactions in a Technological Environment: How a Technology Project is Transforming Preschool Teacher Practices in Urban Schools

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Abstract

The purpose of this paper is to present the outcomes of a program to support preschool teachers in using technology within an urban public school district. Forty-six early childhood professionals were engaged in a three-year model of in-depth technology workshops and monthly on-site follow-up visits. The workshops were structured to lead participants from basic computer operations and use of peripheral devices (i.e. digital cameras, scanners), software evaluation and selection, toward the goal of integration of technology within the curriculum.

One broad outcome of this training program was that teachers began to apply constructivist ideas related to computer activities to other areas of their professional practice. Teachers rearranged classrooms, re-invented learning centres, and modified their interactions with children. Further, it led to positive attitudes, greater technology expertise, and skill in scaffolding children's computer use among teachers. Teachers identified three major obstacles to integrating technology in the classroom. Data on each of these outcomes will be presented.

Keywords: early childhood education, teacher education, professional development, learning processes, research.

1 Introduction

In 2000, we initiated a pilot program to integrate technology into the preschools of an urban New England school district. A primary focus of this program was to enhance young children's learning—particularly in literacy and numeracy—and to improve their social competence through the use of developmentally appropriate technology. In addition, this project offered teachers training in the technical operations of various technology tools as well as professional training in integrating technology within their curriculum. The results obtained in year one led us to continue the project for another two years.

2 Goals of the Project

The goals of the project are:

- to design and implement a program that helps preschool teachers, child development associates, paraprofessionals, and the children learn to use technology in more effective and developmentally appropriate ways, and
- to facilitate the integration of technology into the preschool curriculum in ways that lead to positive cognitive and social outcomes for children.

3 Literature Review

Technology, particularly computer technology, has been identified in national policies (ISTE 2000) as well as in research studies (Haugland 2000) as a valuable resource to make education more effective, more diverse, and more interdisciplinary (Clements, Nastasi and Swaminathan 1993). However, there are several caveats to its successful use. Chief among these are issues related to software selection, teacher training, scaffolding children's interactions and equipment. In this project, we were careful to address these issues throughout our planning, implementation and evaluation of the study.

3.1 Software Selection

Software that teachers choose should relate to their theoretical orientation and educational goals, just as their choices of books or manipulatives do. The depth and complexity of the software chosen increases as teachers gain technical mastery and are able to focus on children's responses and the thinking processes promoted by the software.

Bowman (1998) orders software on a continuum from open and active to closed and passive. The most open-ended software—word processor, graphics programs, or

Logo—reflect the thinking of the user and allow the child to play with ideas. Closely related are simulations that provide a structure for children to discover new ideas. Next come computer applications that provide information (e.g. encyclopaedias and the Internet). The most closed software set problems and determine the correct answers (e.g. computer assisted instruction). Educators who wish to evaluate software may want to use scales such as the Haugland Developmental Software Scale (Haugland and Wright 1997).

3.2 Teacher Training

In 2000, the International Society for Technology in Education established six standards for technology proficiency of teachers (ISTE 2000). These standards call on teachers not only to be skilful operators of technology but also to be comfortable in designing and implementing learning environments and curricula that maximize the learning of diverse students. Research has suggested that they do not meet these standards (Cuban 2001).

A 1998 survey revealed that teachers felt that they lacked the necessary expertise to use technology and that their classrooms lacked appropriate equipment (Wood, Willoughby and Specht 1998). Although more early childhood education teachers are using technology with greater comfort and frequency, the truly effective use of technology by teachers is a rarity.

What are the primary concerns of teachers regarding technology? What are the key characteristics of teachers who use it well? The introduction of technology within the classroom in the early 1970's brought forth three basic dilemmas that teachers grapple with even today: Do I have the technical skills? Do I believe in it? How do I use it as a teaching tool? (Swaminathan 2001).

Discomfort with technical skills is becoming less prevalent with more of the 1970s generation becoming teachers (Powell 1999). Nevertheless, it continues to be an important aspect, one that teacher educators should focus on (Filipenko and Rolfsen 1999, Hutinger and Johanson 2000). For instance, many teachers are unaware that input devices like the mouse and the keyboard can be customized to match the ability of their children.

Personal commitment or belief in technology is another factor in teachers' use of technology (Bielefeldt 2001). Many teachers, even those with technical and pedagogical skills, continue to resist change (Wetzel 2001/2002). For these teachers, change can only happen when they feel the need, believe in the power of the tool and view change as possible. Research has shown that most teachers who support technology enthusiastically are also those who are computer literate (Specht, Wood, and Willoughby 1999) and able to take ownership of this new tool (Wetzel 2001/2002). These are important considerations for teacher educators.

Integrating technology within the curriculum needs time, practice and support, and often calls for a radical shift in one's teaching strategies (Clements 1994). Dwyer, Ringstaff, and Sandholtz (1991) found that significant change was observed in teachers' use of technology only in the second year of training. In the second year, teachers reported personal mastery of the technology. They did more team teaching and interdisciplinary problem-based instruction. An important change was their increasing tendency to reflect on their own teaching, to question old patterns, and to speculate about the causes behind the changes. Teachers need in-depth training and practice to conceptualize, internalize and implement an integrated curriculum approach to technology.

3.3 Scaffolding Children's Interactions

Vygotsky's theory places importance on cognitive development as a socially mediated process involving scaffolding (Berk 1999). Studies have been conducted of teacher scaffolding across various curriculum areas (Brodova and Leong 1996, Wollman-Bonilla and Werchadlo 1999). Fleer (1992) studied the teacher-child interaction that scaffolds scientific thinking in five to eight year-old children. White and Manning (1994) investigated the effects of verbal scaffolding instruction on young children's private speech and problem-solving capabilities in public school kindergarten. Wollman-Bonilla and Werchadlo (1999) researched teacher and peer roles in scaffolding first graders' responses to literature. Bennett (2000) researched teachers' use of children's literature, mathematics manipulatives and scaffolding to improve preschool mathematics. Results of these studies show that scaffolding enhances learning across these areas. No recent studies involving teacher scaffolding of technology at the preschool level have been conducted. The present project focuses on teacher scaffolding of preschool children's interactions within a technological environment.

Piaget (1965) believed that very young children have a natural curiosity, but are not capable of abstract concepts or logical thinking. This project is based on the assumption that children differ in their interests and abilities but can learn to reason, formulate hypotheses, and problem-solve at the computer at any developmental stage. In preschools where adults provide opportunities for combined computer and related off-computer activities, children construct literacy, cognitive, and social skills as well as basic number concepts more readily (Haugland 1992). Young children have a natural curiosity regarding technological events and they build up a storehouse of technological knowledge through numerous preschool experiences.

4 Technology for Preschools Project

The Technology for Preschools Project (Tech4PreK) is a community partnership conceived, funded, implemented, and evaluated by three collaborating organizations: a major international business, a large urban school district, and a public institution of higher education. The goal of Tech4PreK is to support teachers of young children in using computers to enhance the development and learning of their students. Specifically, the project helps teachers select and use software and hardware that are developmentally appropriate for children and that promote important learning outcomes. It assists teachers in using technology to plan the curriculum, construct learning materials, observe, assess, and document the development of children, and to communicate child interests, outcomes, and classroom activities to families.

Tech4PreK supports a training-of-trainers model within the school district to allow preschool technology initiatives to continue and flourish over many years. Since Fall 2000, the model has been implemented, studied, and refined in 16 preschool classrooms within an urban public school district. Almost 50 teachers, child development associates (CDAs), and paraprofessionals and 700 children have received services from Tech4PreK. Evaluation data show that the project has a significant impact on the skills, knowledge, and dispositions of preschool professionals in the area of technology. Children enrolled in the participating programs have been found to have greater computer competence and to score higher on kindergarten literacy assessments than those in control classrooms. The purpose of this paper is to report data on teacher outcomes that have been obtained during field-testing of this model.

4.1 Participants

The participants are 46 in-service teachers, CDAs, and paraprofessionals who have taken part in the technology project over the past three years. They work in 16 preschool classrooms within eight schools in an urban school district in the Northeast region of the United States. Table 1 shows the diversity represented by this group of participants.

Ethnicity	Teacher	CDA	Para-professional
African American	1	7	2
Asian	1	0	0
Latino/a	3	10	10
Native American	0	0	0
White	7	3	2
TOTAL	12	20	14

Table 1: Diversity by Participant Role (n = 46)

All of the participants in the present project are female except for one Latino paraprofessional. In this professional development model, early childhood teachers, CDAs and other non-certified staff such as paraprofessionals were trained as a cohort. A classroom team might be represented one year by a paraprofessional or a CDA and the next year by a teacher.

4.2 Key Features

The Tech4Prek model is designed to be implemented over three years. Why so long a time frame? It is our experience that on each year of implementation strides are made by both teachers and children. However, three full years of participation appears to be necessary before professionals feel fully confident and competent in using technology in optimal ways with children. Our observations coincide with findings by Dwyer, Ringstaff and Sandholtz (1991) that teachers must develop gradually through specific stages of emotional as well as skill-related growth before becoming highly effective with computers—a process that takes several years. "One-shot" or once per year training sessions have not been found to be adequate.

In implementing the model, preschool professionals must receive on-going support from early childhood and technology specialists. These individuals may be experienced teachers or instructional technology professionals already working in a centre or school district. They may be specialists from a local university or an educational service centre. Eventually, professionals who have completed training in the project can serve as support personnel for their colleagues. In any case, a group of professionals must be identified, who can *scaffold* novice teachers' technology skills.

This model can be implemented in an entire school district. However, it is recommended that groups of professionals implement the model together. The teachers we have worked with report that collaborating with their colleagues helped them, not only to learn more about technology, but also to overcome anxieties and doubts.

4.3 Evolution of the Tech4PreK Model

4.3.1 Year 1

During Year 1 of the project, investigators visited eight experimental preschool classrooms in three schools to model, for teachers, CDAs, and paraprofessionals, scaffolding techniques at the computer. These were conducted in brief structured activities with small groups of children who voluntarily chose to use computers during free play. Investigators guided children to a particular software program to encourage children to slow down, notice effects of their actions, problem solve, and share their understandings with peers and the investigators. On alternating visits, investigators observed and collected data on children's free play at the computer during free choice time.

4.3.2 Year 2

For Year 2, the project's training was revised to support a "training-of-trainers" levelled model. Monthly off-site training sessions were provided to one participant from each preschool classroom. A morning session was provided for a total of nine novice teachers, CDAs, and paraprofessionals. A more advanced afternoon session was provided to five teachers and one CDA. The principals selected the participants, based upon interest and willingness to become a "trainer-of-trainers" for their preschool staff.

4.3.3 Year 3

In Year 3, the "training-of-trainers" model continued. Training was provided to 25 participants from fourteen preschool classrooms within eight schools (including the Year 2 control school). Four technology third-year trainees, six second-year trainees, and fifteen new trainees participated in the project. Third-year participants received individualized training on digital portfolio child assessment, using technology to facilitate family-school connections and planning for training colleagues at their home school site. First-year and second-year participants received training and workshops and follow-up visits as in previous years.

4.4 Tech4PreK Workshops

The school district, where we field-tested the model, provided substitute teachers for participants on workshop days.

The workshops were structured to lead participants from basic computer operations and use of peripheral devices (i.e. digital cameras, scanners), software evaluation and selection, toward the goal of integration of technology within the curriculum. The professional from each classroom who attended the workshops shared concepts and skills with all other staff working in that classroom. The investigator who made on-site visits to each classroom, after each workshop, assisted in implementing workshop ideas.

Several instructors shared teaching responsibilities in the workshops. Although technology expertise is important, the most critical requirements of this position were an understanding of how young children learn, a willingness to become familiar with all the hardware and software utilized in the project, and effectiveness in teaching adults. The instructors presented, demonstrated, and provided hands-on experiences, following a carefully selected sequence. The program was responsive and flexible in manner to ensure that all training activities were tailored to the individual needs of teachers. A survey on teacher skills and attitudes in technology, adapted from guidelines of ISTE, was administered to all participants prior to the beginning of training. In addition, participants provided written feedback "exit slips" (Swaminathan 1999) on post-it note cards at the end of each workshop to help the workshop instructors plan subsequent sessions.

One or two pieces of software or equipment were introduced at each workshop. The workshop instructor and follow-up staff encouraged teachers to focus on using just one or two items and becoming fully familiar with these, before moving on to others. Each new piece of equipment was introduced, in a hands-on way, at a workshop. For example, teachers explored the use of microphones with children. During the workshop, they practiced installing these and using them with at least two different kinds of children's software. Teachers then returned to their classrooms and practiced using this piece of equipment with children. They installed microphones on computers and guided children in leaving messages on the KidDesk phone message program. Follow up staff visited to help teachers use the equipment. They also guided teachers in thinking of ways to use the microphone that supported the curriculum. A full month of practice with this equipment was provided, before new hardware was introduced at the next workshop.

Following the model, we slowly introduced the early childhood participants to a variety of children's software, one program at a time. Even if software was currently available on classroom computers and was used regularly by children and teachers, we encouraged teachers to learn all of its features and levels, and study all of its potential benefits to children and adults, before moving on to another piece of software. One program we introduced that teachers rated very highly for children of diverse backgrounds was *Kidware*. Working in mixed-ability pairings or small groups, participants analyzed and studied the five levels of *Kidware*. As many of the participants were Latina, the dual language capability of this software and ease in switching to a second language from English allowed them to play with and introduce children in their classrooms to concepts in their native language. Families were pleased with the software, too, and would linger during drop-off and pick-up time to spend some extra moments as their child demonstrated his or her mastery of a particular level of the program.

Stages of children's computer interactions (Haugland and Wright 1997), scaffolding techniques and examples were modelled and critiqued during workshops. For example, when a three or four year old child is in a discovery stage, she or he is freely exploring programs and figuring out what the options are. This may be a time when she or he is forming an attitude toward computer use, learning to view the computer as a tool that can be used for one's own purposes, and beginning to feel more comfortable taking chances. In the workshops, professionals were trained to encourage experimentation, point out consequences, encourage conversation, and follow the child's lead. Some children at this stage appreciate being shown a few simple commands before they take over exploration. A child who is about five years old or a child who may be a bit younger with previous experience often approaches a new program with certain assumptions about how it will work. He or she may not hesitate to try all the commands that worked with other programs. In the workshops, participants were encouraged to be patient with a child's "messing around," practice and repetition.

A major focus was on the role of teachers in supporting young children between the ages of three and five years as they grow in technological competence. The researchers encouraged teachers to use a "low touch" approach by instructing a child verbally first, before intervening more directly or "taking over" control of the mouse. The latter was encouraged only when the child demonstrated frustration in following a verbal suggestion.

4.5 Follow-up Visits

It has been our experience that workshops can only go so far in inspiring curricular change in classrooms. Follow-up visits are needed to help teachers implement strategies they have learned. Monthly follow-up visits entailed support in implementing concepts introduced during the workshops, individualized responses to teachers' questions, concerns, and situations, and minimal technical troubleshooting.

The follow-up support professional engaged in the following activities on each visit:

- observed children and teachers, as they interacted at the computers, and offered suggestions and support for implementing workshop ideas;
- modelled key workshop ideas, by interacting directly with children at the computers. The focus of these interactions was on software and hardware—e.g. a new program for children, a new microphone or mouse—that had been emphasized in the previous workshop;
- met with teachers to learn about obstacles to implementing workshop ideas and helped to find solutions;
- formally gathered data on children's computer competence, using an observation instrument (adapted from ISTE 2000) and shared information with teachers;
- provided minor technology support, if possible (though the majority of technology problems were addressed during the additional monthly visits by a technology specialist professional).

In the field-testing of this project, we hired a separate research assistant to systematically gather data on children's growth in computer abilities and to do follow-up studies on literacy, when participating children reached kindergarten. We contracted with an outside evaluator to analyze all data and to submit a formal report on outcomes to our project partners.

5 Challenges to Technology Integration

Teachers identified several obstacles to integrating technology in the classroom:

- They had difficulty making time, given the constraints of their district's mandated curriculum, for significant "kidwatching" in the computer centre.
- They found it challenging to incorporate technology as a tool to document their on-going observations of children because they lacked knowledge of alternative forms of assessment.
- They lacked skills in using technology tools effectively to share their understandings of children's competencies with district administrators and families.

5.1 Making Time for "Kidwatching"

The school district adopted a new time-intensive preschool curriculum model, which did not include technology. Teachers' focus was on learning the requirements of the mandated curriculum that included sequenced weekly themes. The classroom space was divided into "Learning Labs"—special centres to support children's learning in specific curriculum areas, addressed during group time. Teachers observed children's play and kept anecdotal records on children's experiences within these centres. Teachers noted children's mastery of curriculum objectives and completed pre and post-observation rating reports of children's progress along a continuum of "Not Yet" to "Sometimes" to "Regularly" in meeting these objectives. This left little time for careful observation of children's computer activities.

Each classroom had four Little Tikes computers; most were arranged in a straight-line along one wall. However, since the computers were not written into the mandated curriculum, teachers often did not utilize them, or consider them when making observations or documenting children's play. They had difficulty making time for significant "kidwatching" at these banks of computers, far removed from learning labs.

5.2 Using Technology for Assessment

The teachers were used to writing anecdotal records, scoring rating forms, and completing report card checklists of their curriculum benchmarks. They had not been trained in other types of documentation. After sessions on portfolio assessment, many participants began to plan for observations. They developed on-going data collection strategies using technology (e.g. scanner, digital camera, video, voice files) and set aside time for review of children's constructions, writing attempts, drawings, video clips, recorded language samplings, and photos of children at play.

5.3 Sharing Understandings of Children's Processes and Competencies Using Technology

As training advanced, participants learned about the possibilities inherent in *PowerPoint* presentations for sharing their understandings of children's processes and competencies with families. One CDA created a *PowerPoint* presentation to help parents learn techniques for sharing a book with their children. Others created sequential slides with bulleted statements about a child's social and emotional growth followed by photos capturing the child resolving a problem with a peer. They connected a slide describing a child's fine motor skill development to a scanned work sample of a child's cutting a curved paper mitten. These were basic steps; there was a need for more effective means of connecting knowledge of children's competencies in meeting preschool benchmarks to better inform parents and administrators and make refined curriculum decisions.

6 Effects on Teachers

One broad outcome of this training program was that teachers began to apply constructivist ideas related to computer activities to other areas of their professional practice. Teachers rearranged classrooms, re-invented learning centres, and modified their interactions with children. Further, Tech4PreK training led to positive attitudes, greater technology expertise, and skill in scaffolding children's computer use among teachers.

Surveys of teachers found that 49% rated the level of importance of computers and technology for the development of young children as high; 33% rated the level of importance as somewhat high and 17% very high. Less than 1% rated computers and technology at a low level of importance or not important for the development of young children.

How can these findings be explained? Through this training, teachers began to study the children's software that was originally provided on each computer. They questioned the appropriateness of the software for their children. Our experience has been that many computers in schools include software that is not really geared toward younger children or that is not developmentally appropriate. We taught these professionals how to "turn off" or uninstall these programs. Related to this was whether the useful programs available on the computer were set to a level that was too difficult for preschoolers. The Tech4PreK participants noticed that children were struggling with activities that were too advanced or set at too high a level of complexity. They learned to adjust the existing software so that only those activities that were appropriate for young children were accessible.

6.1 Scaffolding Children's Interactions in a Technological Environment

Observations of teachers showed significant differences in the number and kinds of verbal interactions at the computer. Teachers asked children more open-ended questions as they worked at the computer. Over time, teachers provided less direct prompting. They positioned themselves proximal to the children at the computer, offering a suggestion or two only when requested by a child. As children's competence and confidence grew, teachers' statements to children acknowledged a trust in their budding capabilities, "I know you can figure that out by yourself." Or "Remember when you were working with Shakira this morning, what key did you push when you wanted to see how she made her design?" "What can you do to replay your design?"

6.2 Curriculum Planning

Teachers also rearranged the computers, placing them in the various learning centres and turning on software that supported the kinds of learning they hoped children would experience there. For example, one computer was located in the science lab with software such as Edmark's *Sammy's Science House* and *Thinking Things* as well as Scholastic's *I Spy Junior* available. Another computer was located in the Art Lab with Disney's *Magic Artist* and other paint programs turned on. In the Writing Lab, Edmark's *Bailey's Book House* or Broderbund's *Living Books* series were the types of programs children could access as well as Mobius' *KidWare*. The early childhood staff were starting to see the computer as a tool, one of many choices children could make in exploring concepts in the learning labs.

Teachers used technology more often in curriculum planning. They re-invented learning centres. This included the rearrangement of classroom materials so that paper was accessible for printing out children's work and relocating a table nearby with writing tools available for children to add details or their names to their computer creations. A teacher might visit with a child at the table to help him or her add the creation to a personal book that the class was publishing based upon a classroom theme. A CDA might challenge a child to count the legs of a "bug" he created and printed out using Edmark's *Millie's Math House* "Make-A-Bug". At meeting time, children were encouraged to share their work and reflect upon their ideas with peers. Children were invited to become "experts" in teaching others how to use a particular piece of software or change the colour of the background of a screen in a paint program. Families were assisted in leaving voice messages for their children to access through their individual icons and Desktop "answering machines."

Preschool professionals used digital cameras to capture children's spontaneous processes. Bulletin board space was cleared and allotted for children to post their creations for sharing with peers and family members. Teachers used digital photos for creating personalized and unique learning materials, which were frequently added to learning centres for children to explore further. For example, teachers used digital cameras to create "storyboards" for children with autism. Teachers began to use technology for communication with families. Digital photos of a pumpkin unit were displayed during parent and family night. Teachers used a publishing program to design flyers to inform parents of upcoming events or important school news. As teachers became comfortable with laptops and the Internet, they used e-mail to communicate with the few families who had a computer either at home or at work. Teachers offered families the opportunity to connect and explore the Internet at school. During the workshops, participants brainstormed how to help bridge the digital divide (Primavera, Wiederlight. and DiGiacomo 2001); two schools held technology evenings for families as a result.

6.3 Creating Interactive Electronic Portfolios

In year three, teachers began to create interactive electronic portfolios. They effectively used video, voice files, photos, scanned work samples, and technology rating sheets with rubrics to document learning. The curriculum goals and objectives for children were digitized. Anecdotal forms were, too. This made it more convenient for teachers to tie their observations to curricular goals and objectives. Anecdotal records were hyperlinked by date and content to these benchmarks as well.

One sample anecdotal record below, drawn from a participant's electronic portfolio, provides evidence of a child's reflective problem solving and some dramatic play as she creates a blueprint on the computer:

Anecdotal Record: Sarah, age four: Creating a design in *Millie's* "Mouse House," Sarah used a large square with a large triangle on top to create a house in the centre of her design. She then used ten vertically oriented rectangles to make a fence in front of her house. She constructed her fence working from the right-hand side of the blueprint toward the left. Sarah attempted to add an eleventh rectangle near the border of the blueprint, but the constraints of the computer program prevented her from doing so. Each time she dragged and dropped the rectangle, it would return to its position in the left-hand "shape menu." Finally, after five tries, Sarah dragged and dropped four horizontally oriented rectangles to fill the opening.

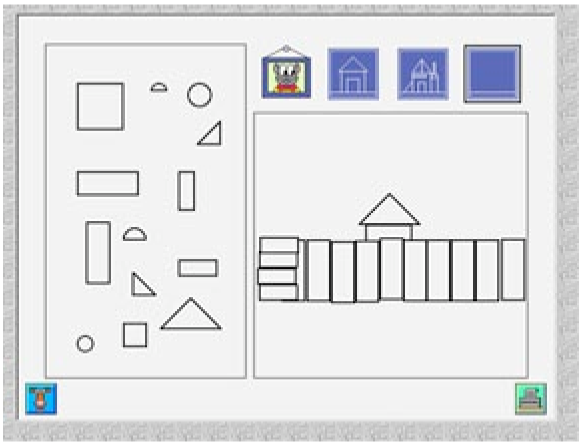

Figure 1: Sarah's Design

The teacher asked Sarah why it was important for her to fill in this space. She stated, "Otherwise, my dog would get out of the yard!"

6.4 Teachers Becoming Trainers

Three third-year participants became trainers of year one and year two participants. Two taught a session on Introduction to *Publisher*, followed by Electronic Portfolios; a third teacher provided a session on Using Technology to Support the Learning of Children with Special Needs. An administrator came to a recent training session to witness his early childhood professionals share their knowledge with peers. He has since invited them to the Superintendent's Council to present their work to the district's principals.

7 Conclusion

Preschool classroom professionals played the most important role in the success of this project. Expertise in technology was not required. In fact, it was our experience that some of the least "tech-savvy" teachers, at the beginning of our project, became our most effective technology professionals. What was required was enthusiasm. We believe that even the most reluctant teachers may grow excited, once they see what technology can do in their classrooms.

A sample teacher response from Nancy, a third-year participant demonstrates just how far she feels she and her colleagues have come in relation to technology skills and attitude:

> *When faculty first visited my classroom, I had to ask a child—a four year old!—to show them how to turn on the computer. I did not know how to do it!' After a brief pause, Nancy reflects, "Now we are doing amazing things with technology. Our lives have changed.*

Nancy is teaching two of our workshops on electronic portfolios!

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