A DESCRIPTIVE STUDY OF TECHNOLOGY USE IN AN URBAN SETTING: IMPLICATIONS FOR SCHOOLS CHANGE

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ABSTRACT

Technology is an integral part of Educational goals today. A study of technology use in a large urban Midwestern school district found that teachers have equipment available to them, but it is oftentimes inadequate, inconvenient, or not working. Teachers would like to use technology, but in reality they don't use it. Part of the reason is lack of professional development. However, software limitations, school district policies that limit access and usage, and lack of technical support also account for this limited usage. Teachers are not requiring their students to use the equipment, but they would like to do so. This is due to limited software and hardware availability, focus on drill-and-kill applications, inadequate funding, and lack of school district vision for technology integration. A model for school change is presented and implications for change in technology usage in schools are discussed.

Keywords: Technology integration, Teacher use of educational technology, Barriers, Instructional strategies, Pre-service teacher's training, Implications for urban schools change.

INTRODUCTION

Technology is becoming an integral part of our everyday lives. Regardless whether the focus of the institutions is rooted in health care, business, industry, service or education, the importance of technology continues to grow in our society. According to Lemke (1998), technology can be used to motivate and engage students in learning. It engages students in real-life applications of academics and encourages students to become more independent and responsible for their own learning. In most school subject areas, technology is considered an important part of the curriculum. For example, in science education, it is believed that technology can help students to engage in authentic inquiry (AAAS, 1993; Rutherford & Ahlgren, 1989; NRC, 1996) and learn important science concepts (Zacharia, 2003).

Today, the use of Educational Technology is recommended in most of the nation's teacher education policy reports (e.g., AAAS, 1993; Rutherford & Ahlgren, 1989; NRC, 1996). These reports aim to develop and articulate a vision of the role of technology in school improvement, the inclusion of technology across the curriculum, and implementation of a technology infrastructure International Society for Technology in Education (ISTE, 2001). Educational standards, including those of the National Council of Teachers of Mathematics (NCTM), International Reading Association (IRA), and National Council for the Social Studies (NCSS) call for technology integration. The author will illustrate this need using examples from science education. In discussing ways to help students overcome science anxiety, *Project 2061* (Rutherford & Ahlgren, 1989) urges teachers to provide students with abundant experience in using tools, including computers (p. 205). Moreover, the authors list the development of computer systems and software to enhance learning science as a "next step" in educational reform (p. 227-228). *Benchmarks for Science Literacy* (AAAS, 1993) highlights the need for students to possess the ability to engage in information processing. *The National Science Education Standards* (NRC, 1996) stress that students as early as grade 5 should be able to "use appropriate tools and techniques to gather, analyze, and interpret data." The use of computers for the collection, summary, and display of evidence is part of this standard. As such, students should be able to "access, gather, store, retrieve, and organize data, using hardware and software designed for these purposes" (p. 145). This content

standard is reiterated as an essential skill for students in grades 9-12 (p. 175).

Throughout the 1990s, however, public school educators were under fire for inadequately preparing students for the demands of the increasingly technology-rich learning environments found in schools. The National Center for Educational Statistics (2001) reported that 98% of schools are now connected to the Internet and 77% of public school classrooms have computers. This finding shows the recent growth of technology in schools. In 1998, for example, it was reported that 90% of the schools had Internet access and 39% of the teachers had access in their classrooms (Becker, 1999). In just four years the growth of technology use in schools increased nearly ten percent. However, in spite of the extraordinary growth of technology in public schools, there is evidence that many teachers still do not use technology in their classrooms (Education Week, 1999). According to a survey of teachers conducted by Center for Educational Statistics (2002), only 22% feel well qualified or are comfortable with technology as a tool for engaging learners in the classrooms. Mouza (2003) reported that quality professional development for teachers to integrate technology into the classroom has been lacking because school districts have been using funds to purchase equipment rather than train their teachers. Further, problems dealing with the availability of equipment and software and the willingness of teachers to integrate technology into their teaching are also common.

Discrepancies exist in quantity and quality of technology implementation. Davis and Falba (2002) reported that elementary teachers typically lack the confidence and background to use technology. Lehman (1994) found in a survey of eighty schools that elementary teachers used computers in science and mathematics instruction most often for drill and practice games. Lehman suggests that experts in technology believe that teachers needed staff development in order to learn how to use technology more effectively. The National Commission on Mathematics and Science Teaching for the 21st Century (2000) reported that technology education still lags in the nation's schools.

Despite the dramatic transformations throughout our society over the last half-century, teaching methods in classes have remained virtually unchanged. Classroom practice has still hardly begun to capitalize on the many dimensions of the learning process. (p. 20)

At the National Technology Leadership Retreat 2001, a variety of content-specific education organizations met to discuss technology's role in education. They were asked why teachers were not integrating technology into their classroom (Bell & Bell, 2002). According to Bell and Bell, one of the common issues cited by the representatives was the perceived inadequacy of the literature supporting technology in education. Although most teachers understand that the integration of technology into the curriculum requires new approaches to the teaching and learning process, not enough effort has been made to ensure that teacher educators are adequately trained (Rowe, 1999). In a study conducted by Czerniak, Lumpe, Haney & Beck (1999), it was found that science teachers believe that educational technology enhances student learning and that the integration of technology into their teaching is both desirable and needed. Yet, they do not perceive that sufficient support structures (funding, equipment, software, staff development, time) for implementing technology exist in the classroom.

Background Information

Considering the need for reforms in education that focus on inquiry-based approaches and technology usage, educators (including the author) at The University of Toledo worked with local schools to acquire funding to assist with these goals. The school district that participated in this study has been the recipient of numerous state funded Eisenhower, Teacher Quality, and PT3 grants. Moreover, the district received large scale funding in the last six years from the National Science Foundation (NSF) under the Local Systemic Change program.

These funded programs exposed numerous weaknesses in teachers' technology background. As educators attempted to integrate technology tools into the

curriculum, it quickly became apparent that teachers lacked basic technological skills (e.g., turning on the computer, using basic software packages, and surfing the Internet). They also lacked the ability to use technology tools (e.g., graphing calculators; PDAs; and computer-based probes for measuring heat, light, and motion). In the NSF grant, lead teachers were selected to mentor their peers. Even these lead teachers lacked technological knowledge and skills. Subsequent funding led us to design several on-line courses to disseminate those developed with NSF funding. The author assumed that teachers who enrolled in on-line courses would be technologically savvy. This did not prove to be true, as many did not know how to configure their Internet access, use WebCT, send attachments, or download files.

Need for the Study

In spite of an influx of funding for educational reforms, we encountered a number of hurdles related to teachers' technological competencies. The author found a need to collect information about the current status of technology needs and technology integration activities across the curriculum. The author also determined that programs should be developed such that it would help schools to address these problems.

Methods

This study examines current issues in urban schools and technology integration to determine how teachers are using technology in their classroom. The study employed mixed methods by collecting and analyzing both quantitative and qualitative data. Additionally, teachers were asked a few demographic questions as to the types of technology they use in their classroom.

Quantitative Data

A checklist was used to gather this information because it reduces the number of errors due to oversight, eliminates the respondents' tendency to over-report, and can be completed in a fairly short period of time (Scriven, 2000). There were no ready-made questionnaires suitable for this study, so a survey was designed as a checklist of technology tools. The survey instrument used for this research was based on ISTE (2000) standards.

Teachers completed the survey by indicating whether they used each particular tool in the classroom, whether they required their students to use the tool, and their interest to participate in a professional development/training to integrate technology into the curriculum.

To establish face validity, an assessment specialist read and checked the meaning of the items in the survey against the ISTE (2000) standards and checked to ensure that the psychometric properties were sound. The instrument was tested and used for the past three-years with the Teacher's Info-Port to Technology, a PT3 grant project at The University of Toledo.

Qualitative Data

The survey included several open-ended questions designed to determine:

1) The school's computer lab use (what types of things teachers teach in the facility ?)
2) What formal technology training (pre-service and in-service) teachers have received ?)
3) If professional development in the use of technology was available free of charge for college credit, and how teachers would participate ?

Sample

A checklist-format survey was used with teachers in a large Midwestern urban public school (grades K-12, including special education). In April 2006, the surveys were mailed to the homes of these teachers (N=2,771). During spring 2006, 2,771 surveys were sent to the homes of these teachers. The response rate was 19.5% with 541 teachers returning the survey (420 elementary schools teachers, 114 high school teachers and 8 no level reported). The majority of the teachers responding to the survey were females 86%, males 13% and 1% with no gender reported. The years of experience ranged from first year teachers to seasoned veterans (44 years). The mean years of experience were 16.51 with a median of 16 and a standard deviation of 9.88.

Data Analysis

Checklist responses were examined overall to determine

the degree to which elementary and high school students are exposed to technology in the classroom. The frequency tallies were used to determine the demographic information of the elementary and high school teachers. The chi square goodness-of-fit test was calculated on "teachers use" and "required student use" to determine whether these categories, by technology tool, exceeded an expected (hoped for) exposure of at least 50% of the teachers. Expecting an average of 50% of the teachers to use a particular technology tool might seem low. This value was selected in order to represent the middle of the distribution, thereby minimizing the statistical significance of mid-ranged frequencies (75%, for example).

The two researchers (an assistant professor with a background in technology education and a professor with background in curriculum and instruction) independently read the teachers' responses to the open-ended qualitative questions to identify themes and supporting evidence from the responses. Trends emerging from the data were coded and categorized using the constant comparative method (Lincoln & Guba, 1985). The researchers met to resolve any differences in opinion and clarify the meaning and language of the identified themes. Themes and quotes that exemplified a high level of inter-rater reliability were used in the analysis of this study.

Results

The results of the survey are presented below and include both quantitative and qualitative findings.

Quantitative Findings

Availability of Technology Tools

Respondents were asked several questions to determine the availability of technology tools. Each item and response rate is listed in Table 1.

Most of the elementary (56.33%) and high school teachers (53.98%) were aware of the existence of a computer lab that could be used for classroom instruction. It was suspected that computer labs might be more available to secondary school teachers; however, the correlation between grade level taught and response to this item was negligible (r = -0.14). Results reported in Table 1 show the use of technology lab availability for classroom instruction by teachers. Of the 56% of teachers who made use of a computer lab for classroom instruction, nearly 17% did so always, 32 % made use of the lab sometimes, and 4% never used the lab for instruction. In addition, the data show that 42.93% of elementary teachers and 45.13% of high school teachers reported that the facility is adequate to serve the use of technology in classroom instruction. Technology use in education is not limited to work in computer labs. However, when labs are the primary venue for technology access (as noted above), 75% of teachers do not make use of the labs. This may be an indication that little technology is incorporated into classroom instruction. It must be remembered, however, that only 30% of the teachers made use of these labs. This is based on the assumption that technology is more readily available in labs designed for technology than in the typical classroom.

	Yes	No	Don't Know
Is there a computer lab available in your school for classroom instruction?			
Elementary School	227 (56.33%)	175 (43.42%)	1 (0.25%)
High School	61 (53.98%)	47 (41.59%)	5 (4.43%)
Do you use it?	Always	Sometimes	Never
Elementary School	55 (13.65%)	82 (20.35%)	75 (18.61%)
High School	19 (16.81%)	36 (31.86%)	5 (4.42%)
Is the facility adequate to serve your class size?			
Elementary School	173 (42.93%)	17 (4.23%)	
High School	51 (45.13%)	7 (6.19%)	
Is the facility adequate to serve your teaching needs?			
Elementary School	112 (27.79%)	49 (12.16%)	
High School	35 (30.97%)	16 (14.16%)	

Table 1. Awareness and Use of Technology Lab

Elementary and High School Technology Tool Usage

Results of the checklist portion of the survey indicated the degree to which elementary and high school teachers themselves use a variety of technology tools, the degree to which they require their students to use these tools, and their interest in learning more about these tools. Tables 2 and 3 provide a summary of overall elementary and high school teachers' responses.

Chi square goodness of fit tests were calculated on the

"I Use It" and the "Required of Students" categories for each tool to determine whether the responses matched a hoped for minimum of 50% usage among teachers ($\alpha = .05$; $df=1$; $x_{cv}^2 = 3.84$). Email correspondences, attachments, and the use of Web browsers were significantly lower among all teachers than 50% use. Only 28% of elementary and secondary teachers required the use of any technology tool by their students, suggesting that while teachers themselves may use a technology tool, its use is not transferred to classroom activities or assignments.

Technology tools that were significantly below 50% use among faculty included: e-mail attachments, spreadsheets, databases, presentation software, graphics design, computer-assisted instruction, resources software, computer-aided simulations, scanners, digital cameras and camcorders, and web page composing tools. The only tool significantly above the expected 50% of usage was word processing at 78%. Teachers' requirement of student use was significantly below 15% in all technology tools except computer assisted instruction (26%) and word processing (28%). This would suggest that teachers do not require their students to use technology in the classroom.

Of the 15 items measuring the highest rate of technology tools usage, there were statistical differences between the two groups in only four areas. Elementary school teachers held significantly higher use for computer-assisted instruction and the use of digital cameras than high school teachers, while high school teachers attached higher use to database and scanners. All teachers indicated that they did not have access to scanners and digital camcorders, but they would like more training in their use. Overall, teachers indicted that they would be interested in learning more about each of the tools listed in the survey. Two tools used the least by all teachers (Web composing and digital camcorders) were also tools that teachers indicated a high interest in learning more about. Finally, 94% of the respondents expressed interest in participating in free professional

Tool	I use it	I require my students to use it	I do not have access to it	I am not familiar with this tool	I would like to learn how to incorporate this tool into my courses
E-mail correspondence	237 (58.81%)	40 (9.93%)	59 (14.64%)	16 (3.97%)	51 (12.66%)
E-mail attachments	140 (34.74%)	81 (20.10%)	78 (19.35%)	43 (10.67%)	61 (15.14%)
Spreadsheets	129 (32.01%)	7 (1.74%)	44 (10.92%)	102 (25.31%)	121 (30.2%)
Word processing	314 (77.92%)	82 (20.35%)	7 (1.74%)	0 (0.00%)	0 (0.0%)
Databases	106 (26.30%)	18 (4.47%)	84 (20.84%)	125 (31.02%)	70 (17.37%)
Presentation software	92 (22.83%)	78 (19.35%)	72 (17.87%)	53 (13.15%)	108 (26.80%)
Graphics design	85 (21.09%)	11 (2.73%)	125 (31.02%)	81 (21.10%)	101 (25.06%)
Computer-assisted instruction	155 (38.46%)	106 (26.30%)	32 (7.94%)	46 (11.41%)	64 (15.88%)
Resource software	139 (34.49%)	57 (14.14%)	95(23.57%)	62 (15.38%)	50 (12.41%)
Computer-aided simulation	23 (5.71%)	10 (2.48%)	126 (31.27%)	102 (25.31%)	142 (35.24%)
Scanners	111 (27.54%)	39 (9.68%)	112 (27.79%)	44 (10.92%)	97 (24.07%)
Digital cameras	180 (44.67%)	34 (8.44%)	75 (18.61%)	29 (7.20%)	85 (21.09%)
Digital camcorders	95 (23.57%)	31(7.69%)	116 (28.78%)	59 (14.64%)	102 (25.31%)
Teacher Productivity software	143 (35.48%)	54 (13.40%)	73 (18.11%)	40 (9.93%)	93 (23.08%)
Web page & composing tools	116 (28.78%)	2 (0.50%)	69 (17.12%)	(80 (19.85%)	136 (33.75%)

Frequency counts (N=403) of elementary school teacher's technology use

Table 2. Overall In-service Elementary School Teachers Responses to Technology use

Tool	I use it	I require my students to use it	I do not have access to it	I am not familiar with this tool	I would like to learn how to incorporate this tool into my courses
E-mail correspondence	51 (45.13%)	3 (2.65%)	39 (34.51%)	5 (4.42%)	15 (13.27%)
E-mail attachments	42 (37.17%)	13 (11.50%)	20 (17.70%)	17 (15.04%)	20 (17.70%)
Spreadsheets	41 (36.28%)	18 (15.93%)	27 (23.89%)	17 (15.04%)	20 (13.27%)
Word processing	75 (66.37%)	8 (7.08%)	20 (17.70%)	4 (3.54%)	6 (5.31%)
Databases	39 (34.51%)	18 (15.93%)	27 (23.89%)	10 (8.85%)	19 (16.81%)
Presentation software	23 (20.35%)	13 (11.50%)	31 (27.43%)	13 (11.50%)	34 (30.09%)
Graphics design	19 (16.81%)	16 (14.16%)	31 (27.43%)	20 (17.70%)	27 (23.89%)
Computer-assisted instruction	26 (23.01%)	13 (11.50%)	32 (28.32%)	9 (7.96%)	33 (29.20%)
Resource software	32 (28.32%)	14 (12.39%)	32 (28.32%)	13 (11.50%)	22 (19.47%)
Computer-aided simulation	33 (29.02%)	6 (5.31%)	30 (26.55%)	18 (15.93%)	26 (23.01%)
Scanners	31 (27.43%)	8 (7.08%)	42 (37.17%)	9 (7.96%)	23 (20.35%)
Digital cameras	30 (26.55%)	7 (6.19%)	40 (35.40%)	9 (7.96%)	27 (23.89%)
Digital camcorders	23 (20.35%)	3 (2.65%)	44 (38.94%)	15 (13.27%)	28 (24.78%)
Teacher Productivity software	39 (34.51%)	4 (3.54%)	32 (28.32%)	11 (9.73%)	26 (23.01%)
Web page & composing tools	10 (8.85%)	3 (2.65%)	38 (33.63%)	12 (10.62%)	38 (33.63%)

Frequency counts (N=113) of high school teacher's technology use

Table 3. Overall In-service High School Teachers Responses to Technology use

development in the use of technology in the classroom if such training was available for college credit.

Qualitative Findings

Several open-ended items were included in the survey to extract information that the selected response items may have overlooked. The author compiled the following results by themes that emerged from the analysis.

Theme 1: Placing Computers for Equitable Access

The first theme, placing computers for equitable access, provides insight into the discrepancy between computer availability and use. Teachers indicated that although computer laboratories were available, access to them was sometimes problematic. The laboratory had limited timeframe availability, an inconvenient location, inadequate software for teachers' needs, and a limited number of computers. Example quotes include:

- *"20 computers for 800 kids. I have never had a chance to use the lab. It is used for math and reading."*
- *"The computer lab is rarely available when it is convenient for me."*
- *"Our computer lab is frustratingly "down" often or the printers aren't working and/or our filter, Bess, makes websites unavailable. The lab is located far from my classroom and no one troubleshoots if there are problems Lab techs are needed!"*
- *"[Computer use is] limited to scheduled CCC* for my class…not used for student activities at my discretion like word processing, Internet research, etc. I would like more flexibility in the computer lab rather than the "canned" program students use 2 x per week."*
- *"…without a computer lab there is no time to have 5 students at a time use computers while the rest are receiving direct instruction or participating in cooperative group work."*
- *"The computer lab teacher installs programs and tells*

** Note: CCC stands for Computer Curriculum Corporation. CCC is known today as Pearson Education Technologies.*

students to follow directions. This is the only opportunity to use computers."

- *"When the lab teacher is absent, we do not do CCC and I teach MS Word, Excel, Power Point, Word Art, and computer use. Kids like it very much."*

Theme 2: Providing Technical Support

The second theme, technical support, also provides reasons for limited technology use. Overall, teachers indicated that computers are oftentimes not in working condition and there is no personnel or technical support for keeping the computers updated and working. Example quotes include:

- *"We had many opportunities for workshops and I enjoyed them and learned quite a few of the technology tools. Our computers have been down quite a bit and I don't have a computer at home so I feel I'm losing a lot of the technology training".*
- *"I just started using Jackson Gradequick. But now my computer will not start or turn on. So I cannot use it or correspond with e-mail".*
- *"We need technology that reliably works. This survey is of no use if we don't have anything that works and when it breaks it shouldn't take 3+ months to fix it".*
- *"Another issue that needs to be addressed is servicing of the computers and printers. What good is it to have computers in your classroom if they are not working correctly? Little if no support staff to help fix the problem. They just become big dust collectors that take up valuable space in the classroom. Nothing is more irritating than to type your lesson plans only to find you cannot print them. The problem has been turned in and no one comes to correct it. So before inservices are offered, I feel the equipment needs to be working correctly".*
- *"[I would be interested in training] if I had access to technology in my classroom."*

Theme 3: Computers in the Teachers' Classroom

This theme indicates that teachers would like to have computers in their classrooms, but the number of computers in each classroom is severely limited or non-existent. Computers may also be outdated. Additionally, school district mandates favor drill-and-kill software programs to prepare for the state's proficiency tests, and therefore teachers aren't able to integrate technology into their curriculum.

Example quotes supporting this theme include:

- *"Our 3rd graders have ½ hour daily to use CCC-related programs. My class has about 20 minutes daily access to Amazing Writing Machine".*
- (In response to participating in professional development): *"If we ever get a lab or a computer in my classroom yes, we've been told the lab is coming. I think they mean the second coming".*
- *"I have 5 computers in my room. These are insufficient for my needs but better than the usefulness of the computer lab".*
- *"There are no computers in our classrooms."*
- *"I am an Educational Technology trainer myself but have no computer in my classroom. Our teacher training program ended and that is why I am now teaching math".*
- *"If I can't use it regularly, I forget how and don't use it later because I have to relearn it. Because I currently don't have access to computers in my art room I haven't taken advantage of the inservice classes because what I don't use I lose".*
- *"Because of the 4th grade proficiency tests, we are mandated to get our students on Reading & Math CCC Programs which leaves very little time for creative projects. We used Study Island this year at my school (another "drill and kill")slightly more interesting. Now that we are "free" for Spring Quarter, I have a series of "Scavenger Hunts" my students will be doing for a variety of subjects and a beginning research project".*
- *"There is not even a computer made available to my classroom* "(music teacher).
- *"There are no computers in the classroomwhy bother taking training!"* (high school reading teacher and yearbook advisor)

- *"The "lab" is for grades 4-6 only. Every classroom has 5 computers in it. The problem is the computers are not working. I've had a "work order" on one of computers for the entire 3 years I've been at the school. Currently, 3 out of 5 of my computers are not usable this is a frustration!"*
- *"I've taken 2 computer classes in undergrad [school] at UT but have not been able to use due to the lack of computers in our school".*
- *"The amount of technology available at my school is not comparable to some students' basements. Textbooks are hard to come by; computers are simply not a priority".*
- *"There is no computer in my room. Computers are not available for art but math, reading only at my school".*
- *"No computer in classroom not one computer! [The school district] installed empty outlet strips 4 years ago that's as far as progress goes. The news paper and top leaders give a different impression to the public especially when a levy is needed. Sorry if this is negative".*

Theme 4: Providing Ongoing Professional Development

As can be seen in the previous theme, the majority of teachers would like professional development opportunities, but feel frustrated that professional development would be a waste of time without functional and available computers. In this theme, teachers indicated that professional development must be mandatory for all teachers, including special education teachers. Additionally, they want to learn to use technology tools throughout their curriculum, not as drill-and-kill exercises. Finally, when professional development is provided, it is inadequate and does not provide teachers the time to learn to fully use the technology.

Example quotes include:

- *"I think all teachers need to be using computers in the classroom. It is very difficult with so few available when needed. Also, my training and skills are quite inadequate. I could and need to be doing more. I would be very interested in intensive training of any kind".*
- *"I believe the only way to get most teachers to use the technology available is to require in-services. This would need to be on a scheduled inservice day, during school hours, which [the school district] does not do".*
- *"[Would] like to become more proficient in use of scanners & digital cameras for classroom use. Would use these things for making classroom books and recording events in the classroom. I am not interested in computer programs like CCC which is nothing but an electronic ditto sheet".*
- *"Most of my computer learning has been informal on a need-to-know basis provided by my son or husband or colleagues".*
- *"Special E. was not included in the paid in-services for teachers".*
- *"Most in-services do not provide enough time to fully understand the computers in our classrooms".*
- *"The in-services were very basic and only gave enough information to get started".*
- *"There needs to be a course designed to not only use/teach computers, but how to write lesson plans around their use. For example, I have no idea how to assign five students computer work and keep 25 other students busy on something else. How do you hold them responsible for using the computer time appropriately? What, exactly, do you assign for computer use?".*

Theme 5: Choosing Appropriate Software and Hardware

In this theme, it became evident that teachers are not provided with software that supports their instructional goals. In particular, this is a problem for specific subject areas such as music and art. When professional development opportunities are provided, the lack of software is a barrier to implementing new skills learned in the in-service programs. School district policies that limit software programs and Internet access discourage teachers from using the computers with their students. Example quotes to support this theme include:

- *"I am a music teacher. There is a computer lab in our school and I marked that it is sometimes available. However, it is not set up in any way for music and I have never taken a music class there. A lot would have to be planned out so this could some day be a reality (purchase of music software, etc.)".*
- *"[The school district] does not meet national standards in arts education with regard to technology. Arts specialists are not given access to computers at [the school district]. We often do not have classrooms and are therefore prevented from incorporating technology in the arts!! Thank you for this opportunity to expose an often overlooked weakness in our instructional program!".*
- *"I have attended several in service classes mostly in the summer. My problem has been that I don't have access to the programs following the in service so I don't get to practice and therefore I forget what I was shown by the time school begins. It would be very helpful to continue using these programs over the summer when you have the time to feel comfortable with them".*
- *"Our computers are used daily for the CCC program and also disks (such as Reader Rabbit) during center time. For other computer applications I prefer to use my home computer. Our computers at school are very slow and irritating to use. We are also limited on disks we can use on them because the disks tend to "crash" the computers and it takes a long time to fix them".*
- *"I have one computer in my room, about 5 years old. I use it only for my grading program which I could do on my home computer I also have a printer. I was promised that would be hooked up to the Internet in the fall 2001-02 school year. It never happened. Until we have the hardware and are wired I'm not interested in exploring any possibilities requiring the use of computers".*

Theme 6: Obtaining and Sustaining Funding

In this theme, it is clear that inadequate funding in this district limits access to up-to-date software and hardware, working computers, and professional development offerings.

Example quotes include:

- *"It seems to be impossible for [the school district] to compete in the technology field. We have very little money for equipments and/or inservices. The computers labs we have are old, boring (tutorials). The kids don't have access to the Internet not the technical aspects of running a computer. The teachers have less time than the kids for learning about computers. We don't have e-mail unless we pay for it. It's hard when schools will never be as up-to-date as business".*
- *"My knowledge exceeds the hardware & software available to me. There is far too little money for the software that is available. The six computers are six year old hand me down Power Mac's from the vocational area".*
- *"My classroom is equipped with five computers from SchoolNet monies. These are used throughout the day for curriculum support and individualized instruction".*
- *"The biggest limitation in my classroom and building is that there are not enough computers for my students to use. The same is true of items like a scanner and digital camera. There is one of each for a faculty of 50+ and a student body of 700+".*
- *"Our computers are very slow".*
- *"[The school district] high schools are in the "ice age" as far as computer usage. I will retire after next year and sadly will miss the revolution when it hits".*
- *"I have a computer science major. I just need a computer. I was given a 486 with no printer, no modem and the only software was Solitaire. I would immediately implement its use in lesson plans i.e., research papers for my honors students or searches for Level I. All I have in my classroom that's useable is a telephone jack. When I am asked what equipment I have in my classroom, I tell people I have jack!".*

Theme 7: Determining Effective Goals for Technology Use

In this theme, it appears that an ineffective school technology plan creates a limited vision and lack of technology articulation across grade levels. Ohio's proficiency testing seems to dictate the technology vision in this school district. Some teachers are not convinced that technology enhances the teaching and learning process, and others do not value computers.

Example quotes include:

- *"Need desperately to start at our kindergarten level as a base for keyboarding and work on up into the [higher] grade levels".*
- *"I wish I did know more about technology and how to incorporate it in my classroom. My kids are excited about it and they only have limited access".*
- *"The computer lab in my school is for grades 3-6 and they work on skills that will help students with proficiency tests".*
- *"The use of technology in teaching is still being "thrown" at teachers without any research showing its effectiveness. I am not resisting it because of any unfamiliarity I may have with it but as the untested tool that it is".*
- *"I do not deal with computers. Computers are the downfall of our society."*

Conclusions

Three conclusions can be drawn from these findings.

1. Teachers have equipment available to them, but it is oftentimes inadequate, not conveniently accessible, or not working. Software and hardware limitations and lack of technical support account for much of the lack of technology usage.

2. Although teachers would like to use technology equipment, they don't personally use it. Part of the reason is lack of professional development. However, software limitations, school district policies that limit access and usage, and lack of technical support account for this limited usage.

3. Teachers are not requiring their students to use the equipment, but they would like to do so. This is due to limited software and hardware availability, focus on drill-and-kill applications, inadequate funding, and lack of school district vision for technology integration.

Discussions and Implications

Students in urban E-Rate settings are, controlling for other factors, more likely to face constraints related to the adequacy of teacher and student technology skills, the availability of technical support staff, building electrical systems, and the speed and reliability of their Internet connections… Moreover, controlling for other factors, students in large E-Rate schools are less likely to have teachers who use educational technology and who use computers for "complex" purposes in their classrooms (Puma, 2002).

The quote above is typical of urban settings and depicts many of the same things we found. Knoster's (1991) model for managing complex change (Figure 1 below) provides us with a framework for discussing these findings and suggesting implications for others.

Figure 1: A Model for Managing Complex Change

Knoster's model states that there are five main elements needed for successful change to occur: vision, skills, incentives, resources, and action plan. The model suggests that the lack of a vision causes confusion. When people lack necessary skills needed to make changes, they become anxious. When incentives are missing, change can be either a gradual process or people can become resistant to changes. If needed resources are missing, people become frustrated. Finally, when an

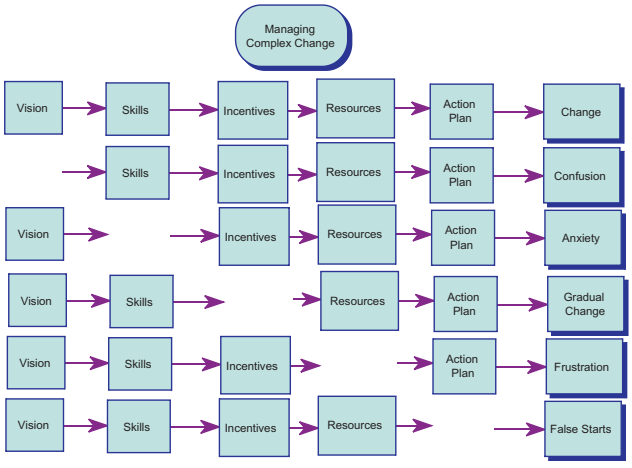

Figure 1. A Model for Managing Complex Change

action plan is absent, one oftentimes sees multiple false starts. This provides us with a focus for examining what might happen when elements are missing from a systemic change process. Each element will be discussed below.

Vision: Across the country, states and school districts are developing and implementing technology plans and related policies to ensure that the schools are in compliance with state and national technology standards. Moreover, school districts are aware of the value of technology use in the classroom to enhance the teaching and learning process for all students. In order for the technology plan to be successful, the leadership must invest in the process to make sure that technology is integrated across the curriculum in the teacher's classroom. Byrom (1998) stated that if technology is to be used to improve on student accomplishment, teachers must see a direct link between the technology and the curriculum for which they are responsible. Byrom (1998) states, "truly integrating technology into teaching and learning is a slow, time consuming process that requires substantial levels of support and encouragement for educators" This process may take two to three years in technology-advanced schools and even longer in schools with limited technology resources. Thus, a long-term strategic plan and vision are needed.

However, research findings show a discrepancy between what is desired in technology education and what is practiced. For example, nationally, it is reported that less than one-third of inservice teachers using technology (Becker, Ravitz, and Wong, 1999). For those teachers who use technology, it is mostly drill-and-practice rather than inquiry oriented. Survey data collected from 2,894 teachers in Massachusetts found that teachers use technology more for lesson preparation and communication than for instructional purposes (Russell, et al., 2003). It may be that a lack of guiding vision causes these gaps and problems.

Our findings support this assertion that lack of a guiding vision causes confusion. There was no well-designed technology plan that was developed by administrators, teachers, technology coordinators, students, parents, and representatives of the community to promote student learning. School district leaders must address their technology vision plan in order to provide opportunities for teachers to engage in ongoing professional development and select appropriate software to effectively integrate technology into the curriculum. Not surprisingly, most teachers report that their students are excited to use technology in the classroom. However, the teachers' job is more challenging and difficult due to lack of modern hardware and software, as well as adequate preparation in the effective use of computers within the classroom. Part of the problem is that school districts frequently purchase hardware and software without the teachers' input, do not provide sufficient time to become familiar with the new equipment, and have inadequate allocation or funding.

As Knoster's model illustrated, lack of vision causes confusion among teachers and administrators, and it may develop opposition because of lack of apparent direction. The implications for others is that the school administrators must have a clear vision of technology to support student learning. Also, administrators, teachers and staff must play the role in achieving that vision.

Skill: Our 21st century teachers must be skilled in technology if we are to meet demands of our technology driven society, and all capable students should be given an opportunity to maximize their potential (Young, 2002). For teachers, they typically gain these technology skills through either university degree programs or professional development opportunities. Reyni (1996) remarks that professional development time is particularly imperative when teachers are learning new technology skills.

"This time for learning is especially important as schools incorporate information and multimedia technologies into the classroom. When a school proposes to install these technologies, each teacher must become adept at their use, identify appropriate hardware and software for his or her subject matter and students, and sit down to work on the computer. Learning to use new technologies well is accomplished best when teachers time available to learn in a variety of ways. Teachers need large blocks of time to gain initial familiarity with new hardware or

software, learning and practicing for sustained periods. Time to observe an experienced user model an application in his or her classroom, time to design a new hypermedia stack, or time for group reflection on a recently tried application all recommended approaches to professional development should be made available every day." (P.12)

Our findings suggest that teachers in this school district did not have the requisite skills needed to personally use technology or to have their students use it. Many cited the need for professional development opportunities for all teachers, sometimes stating that their students knew more than they did. Knoster's model suggests that people become anxious when they lack necessary skills. Anxiety was evident in teachers' comments such as:

"There needs to be a course designed to not only use/teach computers, but how to write lesson plans around their use. For example, I have no idea how to assign five students computer work and keep 25 other students busy on something else. How do you hold them responsible for using the computer time appropriately? What, exactly, do you assign for computer use?"

The impact of anxiety on learning and performance has been fairly well substantiated in the literature (Czerniak, 1996). Similarly, Orrill (2001) stated that many teachers are afraid to learn use technology integration effectively in the classroom to enhance student learning. The author believes that the implication from this research is that school districts need to assess and monitor teachers' level of anxiety in order to provide appropriate professional development.

The assessment and monitoring of anxiety would help school districts create professional development opportunities tailored to meet teachers' needs. For example, the level of difficulty could be changed to match teachers' levels of anxiety, or support systems could be implemented to help those who needed more support.

Incentives: Incentives are commonplace in grant-funded programs and are designed to encourage teachers to participate in the programs. These often include monetary stipends, materials and supplies, release time, graduate credit, or professional development credits. It is commonly believed that offering incentives encourages teachers to devote their time to professional development.

Knoster's 1991 model suggests that lack of incentives leads to gradual change or resistance. Fetters, Czerniak, Fish and Shawberry (2002) found that incentives are often provided to teachers without reflecting about whether the incentives are truly motivating. Sometimes, incentives are communicated in such a way that they appear to include only extrinsic rewards (stipends, graduate credit, etc.) versus communicating associated intrinsic incentives such as enhancing the ability to provide quality instruction or improve student learning. This was true in a grant-funded program offered by these authors. Some teachers enrolled, received stipends and graduate credits, but dropped the program when implementing the program began during the academic year. The implication is that reform projects should provide both extrinsic and intrinsic incentives that last throughout the project.

Although we did not find incentives to be a theme that emerged in our study, the teachers did respond affirmatively that they would be interested in enrolling in professional development opportunities if they were offered free of charge. Incentives, such as paid release time to collaborate with colleagues, is often difficult to plan and costly for schools. Considering the cost and the importance of both intrinsic and extrinsic incentives in effecting change, schools need to ask teachers for input about the incentives they desire to gain their participation. This information could provide valuable insight into the motivation of teachers and give the school district and university information needed for planning purposes. School districts, for example, may find that they do not need to spend a lot of money to offer extrinsic incentives.

Resources: Trenbusch (1998) argues that, "if school districts don't do a better job of allocating resources for professional development instead of putting all the

budget into technology acquisitionschools will be left with the tools but not the talent to prepare youngsters for a technological world" (p. 2).

One of the barriers to technology integration is the difficulty many teachers face in finding and using appropriate software for instruction. Teachers at novice stages of technology integration are unfamiliar with multimedia software and they feel overwhelmed by the profusion of software on the market. To ease the frustration, software selection activities should involve teams of teachers who have expertise in specific subject areas. If technology funding is limited, the school district may not purchase adequate hardware and software. In many cases, administrators purchase computers without consulting with teachers. Without technical support, technology integration in the classroom will never be successful.

Most teachers in this study have horror stories about hardware failure, software complexity, data loss, embarrassments, and frustration with non-working equipment. According to McKenzie (1998) "The best way to win widespread use of new technologies is to provide just-in-time support, assistance, and encouragement when needed. Not tomorrow. Not next week. Now!" According to Technology and Educational Reform, a U.S. Department of Education report by Singh and Means (1994), "If technical problems arise frequently and teachers have to wait hours, days, or weeks to get them resolved, they will abandon their effort to incorporate technology. Our findings are consistent with the aforementioned studies. Teachers do not use technology in their classrooms due to lack of appropriate software and hardware, and lack of experience to make good decisions about making technology integration effective in the achievement of student learning. As one of the teachers stated, "I have one computer in my room which is about five years old and I use it only for grading. I was promised that my computer would be connected to the Internet in the fall 2001-02 school year. However, it never happened and I am not interested in exploring any possibilities requiring the use of computers in the classroom." Another teacher commented, "The biggest limitation in my classroom and building is that there are not enough computers for my students to use. The same is true of items like a scanner and digital camera and there is one computer for each faculty of fifty and a student body of seven hundred plus".

Knoster's model suggested that if needed resources to integrate technology into the classroom are missing, teachers become frustrated and remain skeptical about the administrator's commitment to technology integration. The implication for others is that a budgetary plan is needed for replacement, upgrades, software, and technical support. K-12 schools must invest and develop strategies in the effective use of technology integration in the classroom, update hardware and software, and design an infrastructure that works.

Action: To improve basic skills, technology needs to be used for stimulating ongoing projects that promote students' high-level thinking skills as an alternative to drill-and-practice programs. Schools need to establish a strategy to implement change if technology is ever to be used effectively. As we have shown, Knoster's model suggests that the action plan is the last step for enacting the vision, skills, incentives, and resources. It is vital that school districts discuss and develop the technology action plan with teachers, students, administrators, parents, and representatives of the community. All must be actively involved to ensure a meaningful impact on student learning.

Without the action plan, one often sees multiple false starts, and teachers may oppose using technology as a means to improve student teaching. Our findings show that these false starts are occurring in this school district. For example, one teacher in the study stated "the district high schools are in the ice age as far as computer usage. I will retire after next year and sadly will miss the revolution when it hits." These teachers clearly seem to view the drill-and-kill approach that the district has adopted as a false start. The teachers would prefer to use technology across the curriculum in more effective ways.

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