Student and Teacher Views About Technology: A Tale of Two Cities?

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Abstract

The purpose of this study is to critically examine teachers' and their students' views about technology integration in schools focusing on the following questions:

1. *What are students' perceptions about technology integration in schools?*
2. *What are teachers' views about using technology in teaching and learning?*
3. *What do teachers say about the "oversold, underused" phenomenon of technology in schools?*

Data were collected from 15 secondary mathematics and science teachers and 450 secondary students. The results suggest that teachers' attitude towards technology uses in schools tends to be negative, while student attitudes can be summarized as enthusiastic. Most importantly, the fearfulness of being replaced by computers contributes to the "oversold, underused" phenomenon.

INTRODUCTION

Schools are increasingly investing in technology. Researchers, educators, policy-makers, and parents are exploring the best ways to integrate technology in classrooms to enhance teaching and learning. Many educators advocate the enhancement of learning with technology (Hoffner, 2007; O'Bannon & Puckett, 2007) while others are apprehensive about the impact of technology integration in classrooms (Cummings, 1996; Drier, 2001). Pedretti and her colleagues (1998) argued that

> As with any new educational innovation, the impact of the changes that accompany the introduction of technology on all the stakeholders needs to be considered. In a technology-enhanced classroom, where teaching and learning may be dramatically changing, the voice of those affected most … must be heard. (p. 570)

Teachers and their students are two important stakeholder groups in any endeavor to integrate technology into schools; their beliefs and views must be thoroughly understood before any initiative takes place. This study, therefore, examines teachers' and students' views about the integration of technology in schools focusing on urban and rural secondary mathematics and science teachers and their students.

Systems Theory: A Conceptual Framework

This study is grounded on the "systems design" theory that concerns with "a systems view of the world and the elucidation systems thinking as an approach to theoretical and real-world problems" (Banathy & Jenlink, 2004, p. 39). In this view, all human systems are purposeful and purpose-seeking systems. The design

of any system, such as an educational system, needs to serve the purposes (1) of the system, (2) of its people and parts, and (3) the larger systems it belongs to (Banathy & Jenlink, 2004).

This systems design approach, therefore, envisions

> the entity to be designed as a whole, as one that emerges and is designed in view of—and from the synthesis of—the interaction of its parts. A systems view suggests that the essential quality of a part or component of a system resides in its relationship with and contribution to the whole. Systems design requires both coordination and integration. (Banathy, 1994, p. 28)

Human systems are unique because culture plays a significant role. Educational systems, therefore, are value-guided, culturally embedded, and interconnected. When biological and reproductive needs are fulfilled, cultures respond to supra-biological values, i.e., to satisfy individual and social values. It is important to realize that all cultures address such supra-biological values in ways that depend on the specific values of the people within the cultures (Banathy & Jenlink, 2004).

A technology-enhanced environment, therefore, can be viewed as a system that emerges from the interaction of its components. These components are the critical stakeholders and include students, teachers, and administrators. These stakeholder groups interact with each other and carry out certain tasks that enable the environment to function. For example, students' and teachers' beliefs about technology may affect their adoption of the tools which directly contributes to the establishment of a technology-enhanced environment. Further, administrators' understanding of technology-related issues may affect school policies. This, in turn, may influence the integration of technology in schools and reshape the environment.

As a result of these factors, the establishment of a successful technology-enhanced learning environment entails a solid understanding of each of its components in the context of its own culture. This study seeks to understand the two important stakeholder groups in the educational environment in North America: teachers and their students. The following research questions guide this exploration:

1. What are students' perceptions about technology integration in schools?
2. What are teachers' views about using technology, including advanced communication technology, in teaching and learning?
3. What do teachers say about the "oversold, underused" phenomenon of technology in schools?

RELATED LITERATURE

Various studies have explored the use of technology in the classroom. In particular, researchers have examined the integration of technology into mathematics and science classrooms, focusing on the perception of teachers and students. The following review of the related literature has been organized by teacher perceptions and student perceptions.

Teacher Perception

The literature on teachers of mathematics and science has explored their beliefs on teaching and learning, their attitudes toward computers, and the obstacles they perceive in integrating technology. Some researchers (Garthwait & Weller, 2005; Kim, Grabowski, & Song, 2003) claimed that teachers' educational beliefs about teaching and learning, about students, about pedagogy, and about the role of technology strongly influenced the integration of technology. For example, Kim, Grabowski, and Song (2003) conducted in-depth interviews and classroom observations of five middle school science teachers. The teachers perceived that using Web resources made students' learning more dynamic and active. This approach motivated students to be more active in the learning process. It also promoted interaction and communication among students and between students and teachers. The Web-enhanced environment forced teachers to change their role from knowledge dispensers to facilitators.

Another study (Yuen & Ma, 2002) examined preservice teachers' computer acceptance and concluded that the perceived usefulness of technology had a significantly positive effect on teachers' intentions to use computers in the classroom. The teachers who reported high levels of personal use were more likely to use computers in classrooms. Further, when a computer was perceived as easy to use, teachers tended to think it was useful and intended to use them in the classroom.

Although successful teachers emphasized the benefits of technology, the attitudes of math and science teachers were generally different. An earlier review of the literature (Schmidt & Callahan, 1992) indicated that many teachers feared that using technology would harm students' understanding of basic math concepts, make them overly dependent on technology, and not be effective as an instructional tool. More recent findings (Drier, 2001a; Drier, 2001b) identified similar patterns. Researchers (Guerrero, Walker, & Dugdale, 2004) summarized teachers' attitudes toward the use of technology in mathematics classrooms as "apprehensive," whereas their students' attitudes were "mainly enthusiastic." The majority of teachers indicated that they had not observed any software that really helped learning and using software did not save time in teaching or evaluation.

Researchers (Demetriadis, Barbas et al., 2002; Pelgrum, 2001) also identified teachers' perceived obstacles. The most commonly cited obstacles to the integration of technology in education were: (1) material conditions (including an insufficient number of computers and insufficient technology expertise among teachers); (2) difficulty integrating technology into the regular curriculum and instruction; and (3) lack of supervisory and technical staff.

Another significant issue identified in the literature was the "over-sold, under-used" phenomenon. That is, researchers found that computers have been available at nearly all schools, but have not been used by many teachers (Cuban, 2001). According to Rosen and Weil (1995), many elementary and secondary teachers were techno-phobic and were most anxious about dealing with the actual hardware in classroom settings, about computer crashes and errors, and

about learning to use computers. Most importantly, techno-phobia was not caused by a simple lack of exposure to technology. These issues were also well documented in more recent works including the well-known book by Cuban (2001).

Student Perception

Compared to teachers, less attention was paid to exploring students' perceptions of the technology used in math and science classrooms. Several studies (Ng & Gunstone, 2002; Nugent, Soh, & Samal, 2006; Shyu, 2000;) explored the influence of technology and concluded that technology could motivate students to learn mathematics and science. When the Internet was used in science classrooms, students appreciated the rich resources and the increased accessibility of information provided by the Internet. For example, Ng and Gunston (2002) studied grade 10 Australian students and found that the students perceived four advantages and four disadvantages of the Web as a research tool. The advantages included: (1) unlimited information; (2) increased accessibility; (3) allowed open, self-directed learning; and (4) improved technical skills. The disadvantages involved: (1) the difficulties of finding good Web site information; (2) time-consuming; (3) substantial assistance needed; and (4) technical glitches. Comparing this with the research studies focusing on teachers discussed above, we could see several parallels between teachers' and students' perceptions in technology integration in schools.

Some (Galbraith & Haines, 1998; Pedretti, Mayer-Smith, & Woodrow, 1998) argued that the voices of students, those most affected by technology implementation, must be heard. According to Galbraith and Haines (1998), not all students were confident in the use of technology, nor were many convinced of the benefit of technology-based instruction. In their study, no students reported that they preferred to learn science exclusively through the use of computers, although they acknowledge the benefits of using technology. In other words, students viewed technology as an enhancement to the learning process rather than a substitute for it. This point, scholars (Pedretti, Mayer-Smith, & Woodrow, 1998) argued, should help diminish any fears that teachers might have about being completely replaced by technology in the classroom.

Students' view about specific software in mathematics and science learning was another topic of exploration. For example, D'Souza and Wood (2004) examined student concerns and resistance towards spreadsheets in mathematics instruction. They found that students generally had a mistrust of software and felt more comfortable with their "tried and true" traditional methods. Many students preferred pen and paper methods because it was more reliable and easier than spreadsheets and they could see all their work sequentially as they wrote. Some cited the irrationality of using computers for in-class work but being tested via pen and paper methods. Overall, the investigation uncovered a wide variation in the learning needs and styles that students brought to the computer-based learning of math.

Few studies had examined technology in mathematics and science classrooms by considering students and their teachers at the same time. These limited

studies were conducted in areas outside North America. For example, a study (Zoller & Ben-Chaim, 1996) conducted in Israel examined the computer inclination (CI) of 501 grade 11 students and 53 of their teachers. CI was defined as the resultant tendency to work with computers including their attitudes and beliefs. It was concluded that teachers, more than students, consistently rated themselves as having more positive attitudes and comfort levels about working with computers, as well as a greater belief in the importance of computers and the educational benefit. Students provided similar positive ratings, but not to the same degree as teachers.

Although the literature outside the North American context provided useful information for the understanding of our educational systems as a whole, it is nonetheless insufficient and may not be applicable to North American settings. As systems theory suggests, educational systems are culture-based and reflect the social and individual values of people in the system. The above review of the related literature suggests a lack of exploration of the views of both math/science teachers and their students about technology, and calls for an understanding of their perceptions, particularly in the North American context.

METHODS

This study used mixed methods for collecting data, and focused on affective outcomes. The primary approach was a qualitative study with a survey method nested within it (Creswell, 2003). This mixed method approach enabled me to draw on all possibilities (Tashakkori & Teddlie, 1998, as cited in Creswell, 2003) and provided a broader perspective to study the two components (i.e., teachers and their students) in an educational system, with the qualitative data helping to describe aspects the quantitative data could not address (Creswell, 2003).

Data and Procedures

Two sets of data (teacher and student) were collected in 2005 for this study. The teacher data included interviews of 15 secondary mathematics and science teachers (eight females and seven males; eight urban and seven rural) in two urban schools and two rural schools in Canada. These schools were chosen as a convenience sample because the researcher had access to them. The teachers were intentionally chosen to reflect a wide range of teaching experience. Of the teachers, David had taught for 30 years and was planning to retire soon. Sally was a beginning teacher in her first year teaching in an urban school. The remaining teachers had teaching experience ranging from six to 15 years. In this paper, pseudonyms were used.

Semi-structured individual or focus-group interviews were used to collect teacher data. The interview topics ranged from questions about their professional experience to their experience of integrating technology into teaching and beliefs about the role of technology in education.

After the interviews, the teachers invited their students to participate in this study and a total of 575 (265 male, 310 female) grade 7–12 students (358

urban and 217 rural students) completed the survey which comprised the student data. Table 1 provides student demographics.

The student survey questionnaire was adapted from two survey instruments developed in previous research studies (Grabe, 2001; National Rural and Small Schools Consortium, 1986) including two open-ended questions. The open-ended questions asked in what ways students found technology useful/effective for their learning as well as their preferred ways of using technology in learning.

In this study, each of the two urban schools had one or two computer labs with 15–20 computers in each lab. In addition, every classroom was equipped with one or two station computers. One rural school had a lab with 15 computers and no computers in the classrooms. Another rural school had 10 iBooks. The degree to which the participating teachers had used computer technology in their classrooms ranged from occasional to frequent. Table 2 (pp. 384-385) provides details of the teachers' background.

Analysis

Qualitative thematic analyses of teacher interviews and student answers to the open-ended questions were employed. First, I tallied responses to each question in their data set while searching for patterns that related to the guiding research questions (Creswell, 2003). An initial analysis of student views resulted in the following categories: motivation, confidence, beyond school work, pedagogy, efficiency, future preparation, and anti-techno incentive. Next, I grouped data clips that addressed each theme. Finally, I developed concept maps based on the systems theory framework. These concept maps were based on the organization of the broad theme categories and their constituents as well as to make interconnections explicit.

To insure the trustworthiness of the study, multiple sources from varying perspectives and multiple data-gathering methodologies were used to triangulate data. Member-checking was also used for the teacher interview data. Two graduate assistants and I coded a set of sample data. The inter-rater reliability was measured in terms of raw agreements (student: 0.98, and teacher: 0.85).

RESULTS

In this study, the views of students and teachers about technology in classrooms were examined. Whenever possible, I compared the two populations to identify patterns and to reveal interconnections.

Student Perceptions

What were students' perceptions about technology in learning? In the survey, the open-ended questions asked for students' views about technology in general rather than about specific tools. Hence the students responded to the questions considering *technology* as a broad term. The survey results showed that 87.3% of the students liked to use technology and believed it could be effective in learning. To explore these views, the analysis was focused on students' comments on the ways of using technology effectively in their learning.

Table 1: Grades of the Student Responders

Grade	Percentage*
7	16.3
8	10.2
9	5.9
10	30.8
11	13.8
12	22.8

**Percentages may not add to 100 due to missing values.*

Their narratives generally fell into the following four categories: (1) increased efficiency and the need for change; (2) pedagogy; (3) future preparation; and (4) increased motivation and confidence. These themes are outlined in Table 3 (p. 386) and discussed in the following section.

Increased Efficiency

The first theme was that technology could increase learning efficiency. More than 73% of the students commented that they found technology to be very useful because of its efficiency. This recurring theme fell into two categories: (1) technology allowed easy access to information and cutting-edge research; and (2) it made learning easier. For example, a female student from an urban school remarked: "Learning using computers allows students to access cutting-edge research and information unavailable in textbooks. Simulations also help with comprehension." Many stated that technology allowed for an easy, fast access to information. Other than easy access to information, many students thought that technology could make content easier to understand: "I find it easier to understand when it's on the computer."

Another recurring theme identified in student comments was that technology could provide fast, reliable information and it could enable a more professional presentation of their work.

- It gives more access to information, generates reliable, more accurate data and information;
- It makes my assignments neater.

However, about 25% of the students declared that changes were necessary. They called for more frequent use of technology and more advanced technology in schools. The following comments exemplified this concern:

- I want to see technology being used everyday, not just once in a lifetime. There is so much we could do with it but we don't get the chance;
- The technology used in school is outdated and irrelevant. But the technology used at home is invaluable.

Pedagogy

A significant theme that emerged was that the use of technology enabled diverse approaches to teaching and learning, sometimes in ways that could not be achieved by traditional textbook-based methods. About 34% of the students cited this argument, and provided examples and a rationale for how technology

Table 2: Teacher Background and Technology Use

Name	Teaching Experience & Subjects	Gender (Region)	Feel Comfortable with Technology	Technology Used in Classrooms	Computer Technology Used in Classroom
Aaron	8 years Science	M (Urban)	Moderate	• Use the Internet and PowerPoint mainly for demonstration purposes • Calculators	Rarely
Erik	7 years Science	M (Urban)	No	• Download visuals from the Internet • Calculators	Rarely
David	30 years Science	M (Urban)	Yes	• Download visuals from the Internet • Use presentation tools such as PH probe connect with LCD projector • Calculators	Rarely
Don	8 years Math	M	Yes	• Technology is used to help student inquiry project • Various software, the Internet	frequently
Jennifer	10 years Science	F(Urban)	No	• Use presentation tools (i.e. microspore camera and PowerPoint) for demonstration purposes • Calculators	Rarely
Sally	0.4 years Science	F (Urban)	No	• Used a companion disk of the textbook	Rarely
Betty	14 years Science	F (Urban)	Moderate	• Download visuals from the Internet • Use PowerPoint for presentation • Calculators	Occasionally
Bev	10 years Math	F (Urban)	Moderate	• Use Spreadsheet for Finance • Calculators • Use PowerPoint for presentation	Rarely

Jerry	12 years Math & Science	M (Rural)	Yes	• Use the Internet and various software often • Allow students to take control of using technology	Frequently (but not recently because he had weak students)
Jean	6 years Science	F (Rural)	No	• Calculators	Rarely
Kim	8 years Science	F (Rural)	No	• Calculators	Rarely
Mark	7 years Science	M (Rural)	Moderate	• Taught distance students using teleconferencing once • Calculators • Download information from the Internet	Occasionally
Joan	11 years Science	F (Rural)	No	• Calculators	Rarely
Janet	15 years Math	F (Rural)	No	• Calculators	Rarely
Mike	14 years Math & Science	M (Rural)	Moderate	• Downloading information from the Internet • Calculators	Occasionally

Table 3: Outline of Students' Comments

Theme	Percentage of students discussed	Comments
Efficiency	73.6%	• Increased access to information • Made learning easier
Changes needed	25.1%	• Need to use technology more often • Need to use more advanced technology
Pedagogy	33.9%	• Visual and animation • Bring real world • Beyond school work
Future	24.5%	• World is changing • Technology in workplace
Motivation and confidence	18%	• Motivation, fun • Flexibility • Increased confidence

could change the traditional ways of teaching and learning. Using technology to provide concrete examples or visual materials such as animated models and simulations for abstract concepts proved to be effective for student learning, as exemplified in these comments:

- Technology is very useful in my physics class. Sometimes reading about fields, forces, etc., is hard to visualize. Seeing these things demonstrated on Web sites is very helpful and effective.
- [It] can help you learn in ways you can't with books. Helps you to visualize with models and simulations.

Students also indicated that technology helped bring the real world into learning and gave "a more hands-on approach to learning,"

- It is like having a different teacher. If your teacher doesn't identify with your learning needs, sometimes a computer is better.

Another salient theme was that technology provided learning opportunities to enhance knowledge construction beyond regular schoolwork and that technology changed the way people think.

- Technology is effective in my learning because it teaches me to expand my thinking.
- Technology is definitely effective in my learning. I use graphic tools nearly everyday that help me understand the mathematical relationships I've programmed visually. This type of understanding goes much further than school, but also in my creative endeavors and mental "grasp" of everyday living.

Preparing for the Future

Preparation for their future was another important argument for technology integration as cited by more than 24% of the students. They recognize that the world has become technologically oriented; hence, they need to master current technology to meet the demands of the workplace. For instance, some urban students stated:

- Our world is turning itself into a world that is relying on machines and technology; we need to know how to use it so we can advance.
- Technology is imperative to education because it is an integral part of the growing world.

Rural students echoed:

- A lot of our world is based on technology. It is important for us to be able to work with technology on a daily basis. It prepares students who may need it in their future career.

Increased motivation and confidence

Another significant theme was the belief that technology could increase student enjoyment of learning and confidence in their ability. More than 18% of the students cited this reason as to why they found technology useful. Many students emphasized using games or other "fun" ways, from virtual reality to simulation and to the Internet. For example, a rural student suggested:

- Technology is effective for leaning because it is something new for students to do or see. It's a different way of learning that's usually fun for everyone.

Others indicated, "[technology] makes class more interesting." Few students suggested that technology provided the flexibility to enhance student learning:

- Technology is WAY better than the teacher because you learn at your own pase [sic] and it is extremely funner [sic]. School is usually boring;
- [Technology] is hands on and it's interesting to me. I can learn more if I learn it that way.

Increased confidence was another idea iterated by many students. They indicated that using technology allowed them to go beyond basic tasks such as complicated number operations. This, in turn, enabled them to focus on more important concepts and ideas, as exemplified by this female rural student:

- I consider myself not smart at all and with the use of technology such as a calculator, it helps a lot!!!!!! If it was not for technology I would feel soooooooo much dumber!!!

Some students even developed a dependency on technology, as indicated by this urban student:

- I don't know what I would do without my computer/Internet. The material in math would be impossible to learn if I didn't have my graphing calculator.

In short, students were excited about the integration of technology and believed it could enhance learning. This attitude was mainly reflected in their comments from four perspectives: technology (1) increased efficiency; (2) improved pedagogical approaches; (3) prepared them for the future; and (4) increased motivation and confidence.

Teacher Beliefs

What did teachers think about technology in learning? In the interviews, teachers were first asked to share their experiences and views about using technology in their teaching practice. Their answers to this question, therefore,

considered technology in general ranging from calculators to computers to specific scientific tools. We then asked them to comment on their ideas about using advanced communication technology in teaching and learning, focusing on the videoconferencing tools. In the following description, technology was addressed as a general term unless specified as advanced communication technology.

Advanced Communication Technology

An important observation was that all the teachers recognized that students like technology: "Students like computers. They like technology. It is their way of picking up information [Jennifer]." Interestingly, eight teachers expressed their skepticism about integrating advanced communication tools (such as videoconferencing) into learning. They cited two major reasons: (1) students' limited experience with the technology; and (2) the high cost associated with the technology. They believed that students might not like the advanced technology because of limited exposure; we should not have high hopes for the use of those technologies. Jennifer, an urban science teacher, remarked:

> Remember when you are dealing with students, all right, you can only talk about so many things. Their experiences are limited. If [good learning] is not happening in the classroom already, how can [the use of advanced technology] help?

Mark taught senior high mathematics and science in a rural school. He had some experience of teleconferencing. His experience, however, turned him off this advanced technology.

> I was involved in a project for distance learning. We looked at other schools and tried to coordinate such that kids from [different schools] could take my math course through teleconferencing. It actually turned out to be a disaster because students wouldn't show up …. I'm always a little gun-shy nowadays when it comes to advanced technology-related [projects].

When asked, only four of the 15 teachers showed any interest in using videoconferencing for teaching.

Technology in Classrooms

While students have enthusiastically embraced technology, what do their teachers think about technology? Ten teachers indicated that computer technology should be used only when necessary, as shown by Erik's comments: "Technology should be used as an intentional tool and not for entertainment. Teach a concept with technology only if it is necessary. We should use it sparingly."

Aaron, an urban teacher, was eager to show us how he used technology in his physics classes. One approach he used was running an LCD projector from a computer to display Web sites. He thought that technology was useful when it helped students visualize abstract ideas. For instance, he liked a Web site

which allowed his students to input variables and see the graph of their velocity. Although enthusiastic to share his methods of using technology, he stressed that technology could be overwhelming and that the use of technology in learning should be limited.

> Technology can overwhelm kids as well as teachers. Students nowadays are burdened with heavy workloads, lots of curriculum to cover and diploma exams. There just is no room for more activities.

None of the teachers considered that technology could increase student confidence. Nine teachers claimed that they would use technology only for strong students. They believed that the use of technology demands time and certain skills. Weak students needed to focus on the practice of basic skills rather than wasting time on technology integration. Even Jerry, who was enthusiastic about using technology and had used technology extensively in his classrooms, shared this view. He indicated:

> This year I've used [technology] much, much less because my students were really weak so we've been doing a lot of practice. But when I had much strong students, I used [technology] a lot in class.

Several teachers said that the traditional text-book-based approach would be more appropriate for weak students than technology-supported learning. No one considered that since those weak students had failed in traditional textbook-based learning, trying innovative approaches such as integrating technology might actually help. Although all the teachers recognized that their students (regardless of their skill level) loved technology, nobody considered using technology to enhance weak students' understanding.

One factor that contributed to the teachers' willingness to incorporate technology was their comfort level with the subjects they were teaching. When teaching familiar subjects with a high degree of comfort, teachers were more likely to take risks and integrate technology.

> I could see myself using [technology] over the course of the year with math. With physics, this is my first year teaching it, so I can't really speak out of a comprehensive knowledge of it. I would like to do more of where the kids are in on that, you know, sort of wandering off the beaten path in terms of the curriculum itself [Jerry].

Along the same line, Sally, the new science teacher in an urban school, indicated that her task was to survive and struggle through the process. The most important issue for her was to make sure that her students could pass quizzes and tests. She explained:

> Here's a test coming up; [students] need to know all this material, it is better for me to spoon-feed them from a book, do a couple of demos …. It's not really a problem with being comfortable with the

> technology, it's a problem being comfortable with all the kids, …. Most of it now is just at the level of surviving, making sure the kids get the basics that they need … As long as they can do the quizzes and the tests, we're good.

In summary, all the teachers believed that the use of technology in classrooms should depend on the students and on other conditions. The majority of them considered that technology should be used only when necessary. They were cautious about the possible negative effects (e.g., teachers and students overwhelmed by technology) brought about by rich technology use. Further, the teachers' willingness to integrate technology was connected with their comfort level in teaching, in technology, in the students, and in the content.

Why "Oversold and Underused?"

"Oversold and underused," as described in Cuban's work (2001), refers to the phenomenon that computers have been installed in almost all schools but many teachers have not used them. Indeed, previous research has shown that although technology has been available in most schools, relatively few teachers have used it for teaching and learning, let alone explored it in meaningful ways.

Limited resources and fear that technology would take away "real learning" were two arguments cited by 12 teachers to explain the "oversold and underused" phenomenon. A third reason, although directly addressed only in David's comments but implied in four other teachers' interviews, raised some important questions. David pointed out that the fear of losing his job was a major factor contributing to this phenomenon, acknowledging that teachers would instead cite different reasons such as time or curriculum pressure. The most important reason behind this anti-techno incentive for the majority of those teachers, he believed, was that teachers were afraid of being replaced by technology.

- I don't think they have a problem with technology at all. The problem that they have is a philosophical thing, a pedagogical thing. They are looking at this and going, "Is this the first step of replacing teachers in the classroom, where students can sit at a computer?" Sometime in the future, everything can be learned from a computer. So, there are a lot of teachers shaking their heads, and saying, "Nope."

He added that his school board had started mandating technology integration such as putting course outlines online. This had already caused tension between the school board and the teachers. He believed that this big fight would most likely be an ongoing one and predicted that in the future this issue would be taken to the political arena. He confessed that he had the same concern.

- There are many people that [are] still afraid of [being replaced by computers], but they would use different excuses such as limited computers available.

Sally's comments indirectly supported this idea. When asked about her thoughts on the use of advanced technology (such as videoconferencing) in learning, her immediate response was:

> Is that a threat to the teacher? .... So now there is going to be some place that you can go and you can learn this whole lesson on chemistry, then what do you need me for?

Interestingly, the same issue was identified in student narratives. When asked to comment on their preferred approaches of using technology, this urban student remarked: "Suggestion: fire teachers, replace with computers!!!" This shared view of students and teachers raised an important concern: What can we do?

CONCLUSION

Systems theory has provided the theoretical framework for this study. Two critical components of an educational system (teachers and their students) are examined at the same time. The findings suggest that teachers and their students often hold distinct views on the integration of technology in schools. This distinction is reflected in their beliefs about the benefits and disadvantages of technology. One theme does, however, show a parallel result (although from a different angle) between the teachers and students—the emergent theme of "technology replacing teachers."

The most important contribution of this study is not its finding that students generally hold more positive attitudes toward technology than their teacher, because this simply replicates the results of previous research on teacher and student beliefs (Hartmann, 1982). Rather, its significance lies in revealing a broader and more troubling pattern by considering secondary teachers and their students at the same time thus revealing the strong dissonance between teachers' and students' views on technology. In the themes identified in this study, the views of students and teachers were almost always polarized. For example, the student survey demonstrates that the majority of the students have found technology useful and effective in their learning. The students cry out loud for the more frequent use of technology and the adoption of more current technology in schools. They cite various reasons including increased efficiency, motivation, and confidence, as well as preparation for the future, the workforce, and other pedagogical benefits. Their teachers, on the other hand, are far less enthusiastic. Two out of the 15 teachers had used computers frequently, with conditions; that is, 1) students should have strong academic background and 2) the teachers are comfortable with the subjects they are teaching. If the teachers have weaker students or are teaching unfamiliar subjects, computers are not considered. For the rest, computers have been used as no more than "souped-up typewriters" (Guerrero, Walker, & Dugdale, 2004) or for demonstration purposes. Although fully aware that students love technology and technology is students' preferred way of gaining information, these teachers appear to have little appreciation of advanced technology in teaching practices and are reluctant to consider the idea of engaging students in computer-supported activities. No teacher described exposing students to technology in order to prepare them for the workplace. In short, most teachers perceive technology integration as no more than an extra workload

on both teachers and students, with little educational value for the time and effort invested. Their students, on the other hand, enthusiastically embrace technology and call for frequent and better use of it in schools. These results confirm Guerrero, Walker, & Dugdale's work (2004) that teachers' attitude towards technology tends to be negative, while student attitudes can be summarized as enthusiastic.

Systems theory suggests that the purposes of each group in a system must be served first and their values need to be satisfied. The divergence between the views of teachers and their students identified in this study suggests that these two stakeholder groups have different purposes and hence responded differently to the issue. For teachers, as suggested in their comments, their first and foremost need is to survive. This may lead to the belief that technology should *not* be integrated. For example, the new teacher Sally needs to survive through her increased understanding about her students and about the pedagogy. She may believe that teaching without technology has worked for many years for many teachers. Hence, there is no need for her to take extra time and effort to integrate technology. Further, a concern of many teachers, including Sally, is that technology may replace them. Their goal to survive, therefore, leads to their rejection of technology. Another goal of the teachers is to help students to learn better, which may not involve technology. The teachers may consider that learning without technology is even better for various reasons (e.g., time constraints; "students and teachers may be overwhelmed").

Many students, on the other hand, have different goals and priorities. For example, they want to learn in more effective, efficient and fun ways. They also need to prepare themselves for the future to meet the needs of the increasingly technological job market. Realizing that technology can serve these purposes well, the students enthusiastically embrace this tool.

The student comments suggest that technology may help weak students (e.g., the "feeling dumber student") by increasing their confidence level. This implies that integrating technology into learning may enhance students' (including the less advanced students) understanding. Their teachers, however, would use technology only with strong students, if they decide to use it at all. No teacher considered that we can take advantage of computer technology—as an alternative to the traditional approach—to improve weak students' learning.

The strong divergence between the views of teachers and students identified in this study raises serious concerns about the integration of technology in schools. Although students are a critical stakeholder group, their voice is heard only faintly in most school technology initiatives (Pedretti, Mayer-Smith, & Woodrow, 1998). One possible explanation of this phenomenon is that educational research provides scanty information about student views. As suggested in systems theory, in order to establish a successful educational system, it is important to have functional parts that communicate efficiently. Building a successful technology-enhanced environment, therefore, demands effective communication between the critical stakeholder groups including students, teachers, and administrators. The findings of this study, in confirming previous results (Cuban, 2001), show that such communication is yet to

be encouraged. More research is needed to provide further information for teachers, administrators and other "functional parts" of the system.

Another important and more disturbing reason, as suggested by the results of this study, may be that teachers tend to ignore their students' views and desires. All the teachers are fully aware that their students love technology and technology is the students' way of picking up information. Yet, many teachers refuse to adopt computer technology. The fear of being replaced by computers largely contributes to these seemingly contradictory ideas. Ironically, one view that the teachers and students do share is the belief that technology may replace teachers. Regardless of its origin, this shared view may seriously hurt our education system since it contributes to the teachers' resistance to use computer technology in schools. In an educational system, if the two critical components, students and teachers, cannot achieve harmony, the technology- supported learning environment cannot be successfully developed. As explained above, teachers and their students have different purposes that need to be served in a successful system. Our next step, therefore, is to design a technology-enhanced environment (system) so that it serves the goals of teachers, students, and other groups in the system. Future research is necessary on how to design such technology-enhanced educational systems that enable harmony and "the realization of a vision of the future society using systems design" (Banathy & Jenlink, 2004, p. 50).

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APPENDIX: STUDENT SURVEY QUESTIONNAIRE

Section One: About You

1. Sex (circle one): Male Female Grade level_____
2. Ethic background (e.g. Asian) _____
3. Year of birth_____ School _____

Section Two:

Please answer all the questions. Circle the number that most closely reflects your attitude toward each statement.

Questions	disagree				agree
Women can be as good in science/math careers as men can.	1	2	3	4	5
Men are more qualified to become scientists and or mathematicians.	1	2	3	4	5
Careers are good for women as long as they are not the boss.	1	2	3	4	5
Women scientists/mathematicians are weird.	1	2	3	4	5
Women can make important scientific discoveries.	1	2	3	4	5
Scientific research can be done equally well by men and women.	1	2	3	4	5

Women are not reliable enough to hold top positions in scientific and technical fields.	1	2	3	4	5
Both men and women can be equally good in science and math.	1	2	3	4	5
A husband's success in his career is more important than a wife's success in her career.	1	2	3	4	5
A woman's basic responsibility is raising children.	1	2	3	4	5
A woman with a science/math career will have an unhappy marriage.	1	2	3	4	5
Both men and women can combine careers with family life.	1	2	3	4	5
A wife should spend more effort to help her husband's career than she spends on her own.	1	2	3	4	5
Getting married is the most important thing in a woman's life.	1	2	3	4	5
A woman should be considered for a job based on her qualifications regardless of whether she is married and has a family.	1	2	3	4	5
For a woman it is more important to be a successful wife and mother than it is to be successful in a career.	1	2	3	4	5
Women can combine successful careers with successful marriages.	1	2	3	4	5
A woman should have the same job opportunities in science/math careers as a man.	1	2	3	4	5
Men and women should be paid the same amount of money if they do the same scientific work.	1	2	3	4	5
Women should not have the same chances for advancement in science careers as men do.	1	2	3	4	5
Women should have the same educational opportunities as men.	1	2	3	4	5
Women have less need to study math and science than men do.	1	2	3	4	5
We need more women in science careers.	1	2	3	4	5
Men need more math/science careers than women do.	1	2	3	4	5
It is better for a woman to study home economics than chemistry.	1	2	3	4	5

It is wrong for women to seek jobs when there aren't enough jobs for all the men who want them.	1	2	3	4	5
A successful career is as important to a woman as it is to a man.	1	2	3	4	5
I enjoy learning math.	1	2	3	4	5
I enjoy learning science.	1	2	3	4	5
Math is boring.	1	2	3	4	5
Science is boring.	1	2	3	4	5
Math is an easy subject.	1	2	3	4	5
Science is easy.	1	2	3	4	5
Math is important to everyone's life.	1	2	3	4	5
Science is important to everyone's life.	1	2	3	4	5

1. Would you consider a science/math related career? Yes No

Part Three: Your confidence with technology

Please indicate your degree of confidence in using the technology as described based on the following:

1	2	3	4	5
extremely confident			total lack of confidence	

2.	using presentation software (e.g. PowerPoint)	1	2	3	4	5
3.	using computer games and/or simulations	1	2	3	4	5
4.	using digital images (camera; camcorder)	1	2	3	4	5
5.	using word processing	1	2	3	4	5
6.	locating Internet/Web resources	1	2	3	4	5
7.	using e-mail/listserve to communicate with others	1	2	3	4	5
8.	using chat room to communicate with others	1	2	3	4	5
9.	using computer (**not video**) conferencing (e.g. Threaded discussion)	1	2	3	4	5
10.	using video conferencing to communicate with others (e.g. "Netmeeting")	1	2	3	4	5
11.	using multimedia such as HyperStudio	1	2	3	4	5

Part Four: Your belief about use of technology

Please comment in writing on the use of technology in your learning:

1. Is it effective for your learning?
   a. If yes, how?
   b. If no, why not?
2. Can you describe ways you would like to see technology is used in your learning?