ELSEVIER

Technology uses and student achievement: A longitudinal study ☆

Jing Lei [a,1], Yong Zhao [b,*]

[a] *Syracuse University, 336 Huntington Hall School of Education, Syracuse, NY 13244, United States*
[b] *Michigan State University, 115D Erickson Hall, College of Education, East Lansing, MI 48824, United States*

Abstract

Based on data collected from a middle school, this study investigates how the quantity and quality of technology use affect student learning outcomes. Specifically, this study examines how technologies are used by students, what technology uses are popular among students, and what technology uses are effective for increasing student academic achievement. Results suggest that the quantity of technology use alone is not critical to student learning. "How much" matters when "how" is identified. Moreover, when the quality of technology use is not ensured, more time on computers may cause more harm than benefit. With students' change in GPA as an indicator, technology uses that had positive impact on students were those related to specific subject areas and focused on student construction. In addition, analysis of the frequency of technology uses found that, in general, technology uses that had positive impact were not popular; on the contrary, some of these technology uses were the least frequently used. Implications for practice and future research are discussed in this paper.
© 2005 Elsevier Ltd. All rights reserved.

Keywords: Media in education; Secondary education; Interactive learning environments; Teaching/learning strategies

---

☆ Although computers seem to be the dominant technology in present schools and are the main concern of this paper, there are other technologies used in schools. In addition, the study also included other technologies such as telephone and overhead projector. Therefore, we use "technology use" instead of "computer use" in this paper.

* Corresponding author. Tel.: +1 517 353 4325; fax: +1 517 432 4797.
  E-mail addresses: jlei@syr.edu (J. Lei), zhaoyo@msu.edu (Y. Zhao).
[1] Tel.: +1 315 443 1362; fax: +1 315 443 1218.

1. Introduction

There are two major issues concerning technology use in schools: first, the quantity of technology use, in other words, *how much* technology is used and why; and second, the quality of technology use – *how* technology is used and why. In general, the literature concerning technology use has traditionally focused on the first issue, that is, how much technology is used in schools. Much of the criticism of technology in schools has also typically focused on the issue of quantity (see for example Cuban, 2001; Loveless, 1996). In other words, the "under use" of technology in schools has often been interpreted as the low-frequency of uses, rather than the quality or how well technology is used.

However, the importance of the quality of technology use is increasingly recognized because research indicates that even if technologies are used at a certain frequency, not all technology uses are constructive and helpful. For example, Burbules and Callister (2000) point out that technologies can be used well or poorly, and that they have advantages and limitations, so the key issue concerning technology use is how it is used, by whom, and for what purposes. In a study investigating the relationship between technology use and student mathematics achievement, Wenglinsky (1998, p. 3) also points out: "In essence, the study found that technology could matter, but that this depended upon how it was used." Similarly, McFarlane (1997) states: "Computer use alone, without clear objectives and well-designed tasks, is of little intrinsic value." Therefore, an understanding of how technologies are used in schools, what are "good", effective technology uses and what are "bad" technology uses, is crucial in helping students not only use technologies, but also use them in meaningful ways.

Based on data collected from students in a middle school, this study investigates the following questions:

- How much are technologies being used in schools? What impact does the quantity of technology use have on student learning?
- How are technologies being used in schools? What are the most and least popular technology uses?
- What technology uses have positive impacts on students?
- Are positive impact technology uses popular?

2. Defining technology use

Since the use of the same technology can be "good" or "bad", to better discern the quality of technology use, this study focuses on different uses of technology rather than on specific technological objects (hardware or software). "Technology use" is the application of a technology function to solve practical problems (Zhao, 2003). It is different from specific technologies in a number of ways: First, a technology is an artifact, a product, and a tool. It has the capacity to solve certain problems, but this capacity is not realized unless it is connected with specific problems, while technology use is the process of connecting this capacity with a practical problem. For example, the Microsoft Word program has the capacity for literary composition, but only when it is used to write a paper under certain contexts to solve problems or achieve certain goals is it a technology use.

Second, technology consists of isolated and independent artifacts, while technology use is situated in context and connected with the users. "The same technology has different meanings in different settings" (Peyton & Bruce, 1993) . It can be used differently, by different people, and in different contexts to solve different problems or to achieve different goals (Zhao, 2003). For instance, the Internet has the capacity to support communication; and emailing, online chatting, video/audio conferencing, and posting messages to discussion boards are different applications of this function and thus are different uses of the Internet.

Third, technology is a final product in a static stage, while technology use is in constant change. Users may re-invent a technology to solve current problems or to fit it with a context, and the change in the technology use may in turn lead to further changes in the users and/or the context. Change begets change. The interconnection and mutual influence between technology use and its context could arouse cascades of changes, often "moving it far beyond what was originally envisioned" (Peyton & Bruce, 1993).

Finally, technology has one single form. When it is used differently by different people and in different contexts to solve different problems or to achieve different goals, the original technology acquires multiple forms, and one technology becomes multiple technology uses. In summary, technology use is technology-in-context. Examining technologies from this angle allows us to discern the different uses of the same technologies so that the nature of different technology uses can be better understood.

In this study, student technology uses for learning were categorized based on Levin and Bruce's (2001) taxonomy of educational technology, which specifies four categories of uses: technology as media for inquiry, technology as media for communication, technology as media for construction, and technology as media for expression. Specific technology uses were listed for each category. In addition, technology use for entertainment was also included in this study.

3. Methodology

This section describes the participants, instruments, data collection and data analysis of the study.

3.1. Participants

Participants of the study were students and teachers in a middle school in the state of Ohio in the United States of America. The school is located in a middle- and upper-class neighborhood with about 1% of students receiving free or reduced cost lunch. Student enrollment was 237, and the teacher–student ratio was 9:1 (2003–2004 school year). The school has extremely rich technology resources: every classroom is equipped with a computer projector, overhead projector, TV, and VCR, and the whole building has wireless Internet access. In October 2003, the school launched a laptop project which provided a laptop computer for each student.

3.2. Instruments and data collection

Data were collected over one academic year (2003–2004) in two different ways: surveys and interviews. Written consent was sought from teachers, students and their parents. The data

obtained were from students who, with their parents, had given written consent for the research.

3.3. Surveys

The survey data consisted of a pretest survey and a posttest survey. The pretest survey was administered at the beginning of the 2002–2003 academic year. It included the four sections: (1) demographic information, such as SES, grade, and gender. (2) Current technology use, such as "how much time do you spend on working on computers every day," "what do you use computers for," "whom do you turn to when your computer doesn't work," etc. The questions in this section were all multiple choice questions. (3) Student academic outcomes. Students were asked to report their GPA.

The posttest survey was administered at the end of the academic year. It included all the sections in the pretest survey, and had an additional set of questions (Section 4) on student technology uses. Based on data collected from interviews, 28 possible specific technology uses, including computer-related technology uses and other technology uses such as using an overhead projector for presentation and using a telephone for communication, were listed and participants were asked to rate how often they worked on each of these technology uses. All questions in this section were presented as Likert scale questions with a scale of 1–4 (with 1 indicating "not at all" and 4 indicating "very much/often").

A total of 207 students completed the pretest survey, and 231 students returned the posttest survey. Among them, 177 students finished both the pretest survey and Sections 1–4 of posttest survey. Data from students who did not complete Section 4 (technology use) of the posttest survey and from those with more than one third of all responses missing were deleted ($N = 37$). Data from special education students were also deleted ($N = 10$). Ultimately, 130 students' data were kept for analysis. Of the 130 students, 63 (48.5%) were male, 67 (51.5%) were female, 62 (47.7%) were 7th graders, and 68 (51.3%) were 8th graders.

3.4. Interview

Interviews were conducted twice over the academic year. Ten teachers and nine students were interviewed to obtain in-depth perspectives on how students used technologies and for what purposes. The interviews were semi-structured but, in general, the students were asked questions about when, how and what technologies they used, what their favorite technology uses were, and their perceived benefits of specific technology uses. Teachers were asked to share their views, opinions and concerns on student technology use in classrooms.

3.5. Data analysis

Descriptive analyses based on responses from 231 posttest surveys were conducted to find out what the most and least popular technology uses were. The quality of technology use was measured by its impact on students' GPA. Students' pretest GPAs and posttest GPAs were compared to find changes in their learning outcomes. Correlation, *T* tests and ANOVA tests were conducted to explore the relationships between technology uses and change in student GPA. Data from interviews were coded according to the major research questions.

4. Results and discussion

This section presents and discusses the main results of this study: the impact of the quantity of technology use on student learning outcomes, how technologies are used in schools in general, what the most and least popular technology uses are, what technology uses have positive impacts on students, and the current circumstances related to the quality and popularity of technology uses.

4.1. Quantity of technology use: does the amount of time spent using technology have any impact on student achievement?

Results from the posttest survey showed that on average, students spent about 3 h per day on computers during the 2003–2004 academic year. Regression analysis showed that the amount of time spent on computers did have an impact on change in students' GPA over the academic year ($t = -2.695$, ES $= -.047$, $p < .01$).

This initial result indicated that there is a negative influence from the amount of time spent on computers on the change in student GPA. In other words, the more time spent on computers, the less students gain, or the more they lose in their GPA.

However, a closer examination of the data revealed a "no-gain-point" effect of time on computers on change in GPA. As shown in Fig. 1, 3 h per day seemed to be a critical point. Among the students who spent less than 3 h a day, the more time they spent on computers, the more they gained on GPA. However, for students who spent more than 3 h a day on computers, they were likely to experience loss on GPA. This finding indicates that students can benefit from spending up to about 3 h per day using computer technologies; however, when they spend too much time (more than 3 h a day) on computers, the benefit seems to be canceled out or even replaced with a deficit Table 1.

An independent-sample *T* test confirmed the hypothesis that students who spent more than 3 h a day on computers experienced significant loss in GPA compared with students who spent less than 3 h a day on computers. As shown in Table 2, students who spent less than 3 h a day on computers, on average, gained 0.124 in GPA, while students who spent more than 3 h a day
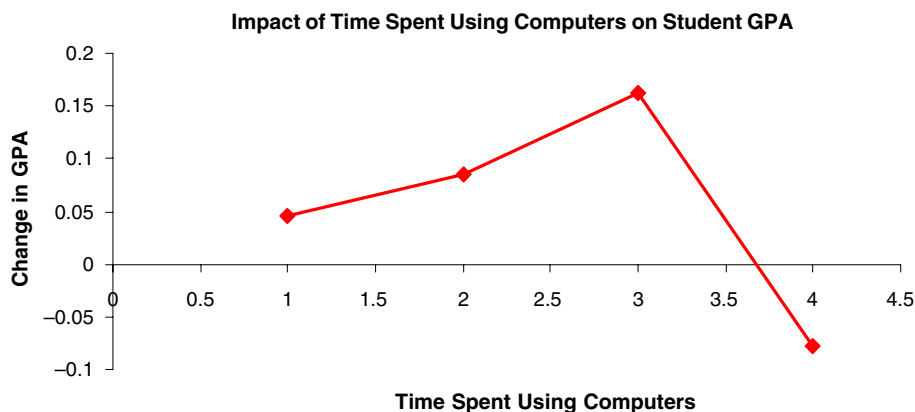

Fig. 1. Impact of time spent using computers on student GPA change.

Table 1
Impact of time spent on computers on student GPA change

Effect	Regression coefficient			t	p-Value
	β	SE(β)	Effect size		
Intercept	.305	.098	0.55	3.113	.002
Time on computers	−.065	.024	−.047	−2.695	.008

Table 2
Difference in GPA changes between two groups

Group	Mean	SD	Mean difference	t	df	p
Less than 3 h/day	.124	.268	.202	4.122	128	<.001
More than 3 h/day	−.078	.271				

experienced an average GPA loss of −.078. The difference in GPA change between the two groups is significant ($t(128) = 4.122$, $p < .001$).

Moreover, Fig. 2 shows that even with the same amount of time spent on computers, different students experienced different changes in GPA. For example, for students who spent about 3 h a day on computers, some students gained more than 1.0 in GPA over one academic year, while some students experienced nearly 0.5 loss in GPA.

This phenomenon suggests that although the amount of time spent on computers has a general effect on student academic achievement, this effect may depend on how they spent their time, with what specific technology, and on what activities. It is reasonable to hypothesize that given the same amount of time using technology, it is the quality of the use that makes the difference in GPA changes. To test this hypothesis, further data analyses were conducted. Specifically, the following questions were explored: how technologies are being used, what technology uses are beneficial to student academic achievement changes, and whether or not beneficial technology uses are frequently used. These questions are addressed in the following sections.
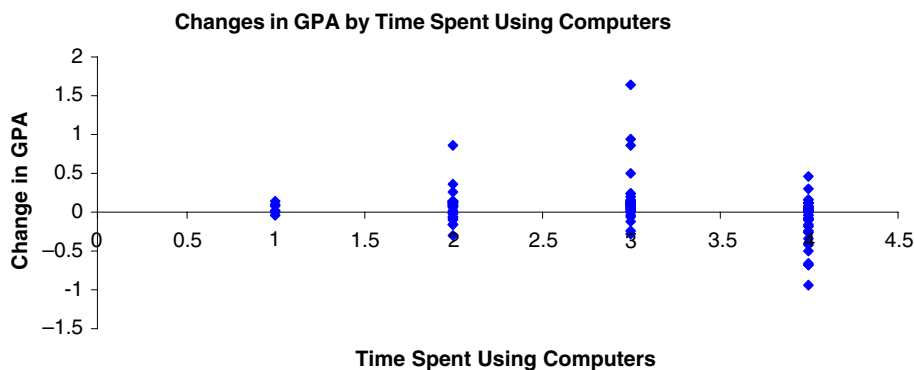

Fig. 2. Changes in GPA by time spent using computers.

4.2. How are technologies being used in schools in general?

As shown in Table 3, most students (81.4%) use computers to do homework, which is a mixture of four kinds of learning with technology, followed by searching information for school work (71.4%), emailing (65.8%), surfing online for entertainment (58%), chatting online (51.1%), and working with specific software (50.2%). About half of the students use computers to play games (48.1%), and only 11.3% of students create websites. In general, technologies are more widely used for inquiry and communication than for expression and construction. This finding confirms previous research findings in Bruce and Levin's (1997) study.

4.3. What are the most frequent and least frequent technology uses?

Table 4 shows specific technology uses with the highest mean frequency on a scale of 1–4 with 1 meaning "never", and 4 meaning "a lot". As shown in Table 4, the technology use with the highest mean frequency is using Microsoft Word for writing (Mean = 3.53, SD = 0.94), and other most frequent technology uses in order are: searching information from the Internet, using Microsoft Word for taking notes, emailing friends, and using PowerPoint for presentation.

Data from interviews also show that the three most popular technology uses are using Microsoft Word for composing various writing tasks, using the Internet to search for information, and emailing friends. Sometimes these three types of technology uses are combined. For example, one popular type of learning activity in this school is the Webquest. The teacher emails students a work sheet in Word format, requiring students to search for information online and answer

Table 3
What do students use technology for? ($N = 231$)

Categories	Specific technology uses	Percentage of students (%)
Mixed	Do my homework	81.4
Inquiry	Search information for my school work	71.4
Communication	Send and receive emails	65.8
Entertainment	Surf online for fun	58
Communication	Chat online	51.1
Expression	Work with some software such as PowerPoint, Photoshop, etc.	50.2
Entertainment	Play computer games	48.1
Construction	Create websites	11.3

Table 4
Most frequent technology uses

Technology uses	Mean	SD
Using Microsoft Word for writing	3.53	0.94
Searching information from the Internet	3.41	0.90
Using Microsoft Word for taking notes	3.28	0.99
Emailing friends	3.18	1.05
Using PowerPoint for presentation	3.18	0.81

Table 5
Least popular technology uses

Technology uses	Mean	SD
Learning with science Probe	1.69	1.00
Telephoning teachers	1.74	1.13
Learning with Aleks	1.87	1.22
Programming	1.90	1.04
Desktop publishing (e.g., writing Newsletters)	1.93	1.04

questions on this work sheet. When working on a Webquest task, students generally have two windows open at the same time, one for Microsoft Word and one for Internet Explorer, searching for information in one window and filling in answers in another window. After they finish answering the questions, they email their complete work sheet to the teacher. These three types of technology uses are also very popular between and after classes. For example, students email their friends frequently, even in class "when I am bored". One student reported that instead of going to the next classroom to talk to her friend during recess, "I just email her and say hi what's going on".

Table 5 shows specific technology uses with a mean frequency under 2 on a scale of 1–4 with 1 meaning "never", and 4 meaning "a lot". As shown in the table, learning with science probes has the lowest frequency (Mean = 1.69, SD = 1.00). Other technology uses with low frequency in order are telephoning teachers, learning with Aleks (a math program), programming, and desktop publishing.

The interview data suggest some explanations for the low frequency of these technology uses. For example, science probes were described by some students as "very cool" during the interviews, and the science teachers also reported that students were very interested in and excited about using science probes. However, the fact that the whole school only had one set of science probes because of their high cost greatly limited its usage. Telephoning teachers, a technology use very popular in previous years at this school, was greatly reduced this year because of the use of email and the Internet for communication and information sharing. Another least frequent technology use – using Aleks for learning – was spoken of highly by a math teacher who believed it was one of the most popular technology uses in the school. This reflects a discrepancy between teachers' perception of student technology use and the actual technology use. This discrepancy further raises the question of how much teachers know how technologies are being used by their students.

4.4. Quality of technology use: what technology uses have positive educational impacts?

Quality of technology use was measured by its effect on the change in students' GPA over one academic year. To examine what technology uses positively contributed to student GPA change, students were placed into three groups according to whether their GPA increased (group 1), did not change (group 2), or decreased (group 3). ANOVA tests were conducted for 28 student technology uses. It was found that students' GPA increased when they:

- Less often used Word to take notes ($F(2,136) = 2.38$, $p < .05$).
- More often learnt with Geometer's Sketchpad ($F(2,130) = 2.34$, $p < .05$).
- More often learnt with Aleks ($F(2,122) = 2.91$, $p = .058$).
- More often learnt with science probes ($F(2,119) = 2.23$, $p < .05$).

- More often created websites ($F(2,119) = 2.42$, $p = .09$).
- More often worked with desktop publishing ($F(2,113) = 8.0$, $p < .01$).
- More often did programming ($F(2,102) = 4.49$, $p < .05$).

The technology uses on which students with increased GPA spent more time can be categorized into two groups. One group includes specific subject-related technology uses, including learning with Geometer's Sketchpad, learning with Aleks, and learning with science probes. These technologies not only are closely related to specific subjects, but also provide ways of learning that may not be accessible in traditional classrooms. For example, the Geometer's Sketchpad program allows students to manipulate geometric shapes and play with different concepts and relationships, and hence helps students to grasp abstract concepts and develop deeper understanding. Aleks, a math program which allows students to learn at their own pace, has a rewarding system which motivates student learning, and a tracking system for the teacher to track and check every student's progress.

The second group includes technology uses that focus on student construction, including creating websites, desktop publishing and programming. A social studies teacher reported that creating websites was well used in his class. In his class, students formed into groups, selected a social studies topic from several choices given by the teacher, conducted research on this topic, and then created a website to present their findings. In this case, the act of creating a website is closely related to the subject content and combines with constructivist ways of learning and teaching.

Students with increased GPA spent less time using Word to take notes. In student interviews, it became clear why using Word to take notes was negatively associated with learning outcomes. Students reported that since the whole school had wireless Internet access, they liked to surf online, check their emails, talk to their friends through Instant Messenger programs, and do this "all the time"; indeed, some of the students were really good at "switching programs if the teacher comes". When using Word to take notes in class – and therefore using a computer with access to these other activities – students were likely to be distracted by or attracted to things other than what the teacher was discussing. This problem even received attention from teachers. One teacher said she did not allow students to take notes on their computers, and another teacher mandated that "the lids of the computers must be shut when I am talking".

4.5. Quantity vs. quality of technology use: are technology uses that had positive impact most frequently used?

The frequency of the most popular technology uses and technology uses that had positive impact is represented in Fig. 3.

As shown in Fig. 3, none of the technology uses that had positive impact on students were the most frequent technology uses. On the contrary, four of the six technology uses that were related to student GPA increase were among the five least frequent technology uses, such as using Science Probes and Aleks. In general, the frequency of usage of technology uses that had positive impact on student academic achievement is not only much lower than that of the most frequent technology uses, but also much lower than the average frequency of all technology uses. Moreover, using Microsoft Word for taking notes, the technology use that seemed to be negatively related to student GPA increase, was one of the most popular technology uses.
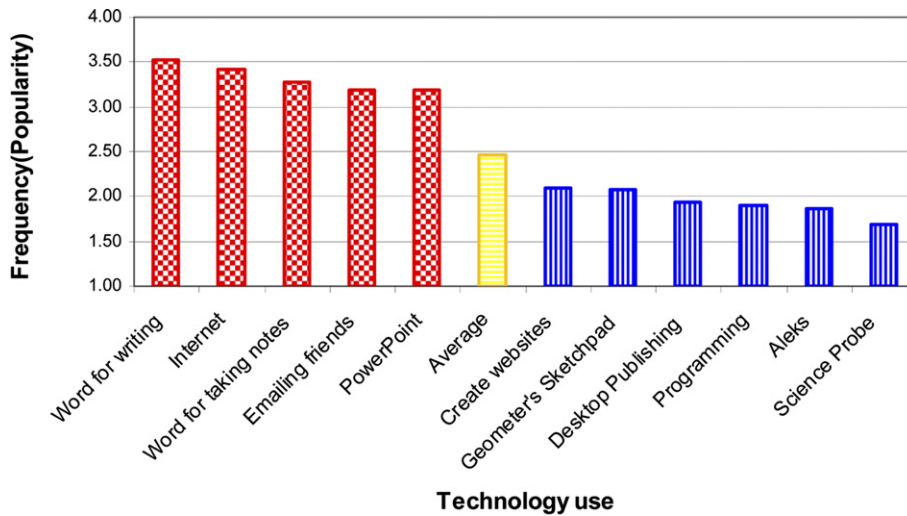
Fig. 3. Frequency of most popular technology uses and meaningful technology uses. *Note.* The five technology uses on the left (shaded with dots) are the most popular technology uses, the six on the right (shaded with vertical stripes), are technology uses that had positive impact on student academic achievement, and the sixth from the left (shaded with horizontal stripes) shows the average frequency of all technology uses.

5. Conclusions

This study explored how technologies were used in a middle school and what technology uses were most helpful in improving student learning outcomes as measured by GPA. The results from this study suggest that, first, although spending some time on computers may help students increase their learning outcomes, too much time on computers can be harmful. The comparison between the frequency of most popular technology uses and that of technology uses that had positive impact on student academic achievement provides a good explanation for this finding: students tended to spend more time using computers in ways not likely to increase their academic achievement. Therefore, when they spent an excessive amount of time on computers every day, they actually were spending most of this time on technology uses that did not directly contribute to academic achievement, so the time spent on technology uses that can have positive impacts and other learning activities was reduced, and hence could decrease their academic achievement.

Second, compared to the quantity of technology use, the quality of technology use is a more critical issue to explore. Quantity of technology use alone is not critical to student learning. "How much" only matters when "how" is identified. Even if students spend the same amount of time on computers, what they use computers for decides whether or not they will benefit from using computers.

Third, using student learning outcomes as the indicator, technology uses that had positive impacts were those related to specific subject areas and that emphasize student construction. It may be, however, that when considering different outcomes as the indicator, the meaningfulness of technologies might be different. For example, although technology uses for communication did not show any evidence of being beneficial in increasing student academic achievement, these uses may help increase or preserve student developmental outcomes, such as attitude and self-esteem.

Finally, technology uses that have positive impacts may not be the most popular among students; on the contrary, they may be the least frequently used. This situation calls for great caution and attention from educators, administrators, teachers and parents. The fundamental goal of integrating technology into schools is to improve student learning. Therefore, encouraging more educationally meaningful technology use should be the focus of educational technology integration efforts.

6. Implications

Findings from this study have some important implications for policy making, technology integration and future research.

6.1. Implications for policy making

Technology is believed to have great potential for improving teaching and learning, and great efforts have been made to promote technology use in schools. In the past, the emphasis has been mainly on how much technology is used. Results from this study suggest that the quality of technology use is a more critical issue. Although students can benefit from some technology use, if the quality of the technology uses is not ensured, then more technology use may cause more harm than good. Therefore, policy efforts should be focused on improving the quality of technology use. Specifically, to improve the quality of technology use, we should encourage more research on technology uses that have positive impacts on students. The quality of technology use has begun to receive attention from educators and researchers, but empirical studies on this topic are still scarce. Sufficient policy and financial support for this kind of research is important in that a sound understanding of the quality of technology use is the premise for any effort to promote meaningful technology use.

Second, education policy, to a great degree, determines how and how much schools integrate technology. With the acknowledgement of the importance of the quality of technology use on student learning, more policy emphasis should be placed on promoting technology uses that have positive impacts in schools. For instance, when evaluating schools based on their efforts toward technology integration, the criteria should not be placed solely on how much technology is used, but on what and how technology is used. In addition, since education policy also influences how funds are allocated and spent, a focus shift from quantity to quality in educational technology policy and standards can help create necessary conditions for technology uses that have positive impacts on students.

6.2. Implications for technology integration in schools

The ultimate goal of technology integration into schools is to help students learn. Findings from this study suggest that the quantity of technology use can have some impact on student learning, but the kind of impact (positive or negative) depends on how the technology is used. What is crucial to educational technology integration, therefore, is not so much how many technology innovations have been purchased, introduced, and installed, or how much time is being

spent on technologies, but how these technology innovations are used by students. Moreover, not all technology uses are equally useful to student learning. Therefore, how to provide more resources and create supporting environments for technology uses that have positive impacts on students are critically important to schools. Specifically, school administrators, teachers, and parents should pay close attention to how students use technology, and should provide guidance to help students use technology more effectively and efficiently. When quality is not ensured, the time spent on technology should be limited. In addition, new regulations and classroom disciplines may be necessary to help students resist distractions and make better use of available technology and resources.

6.3. Suggestions for future research

This study has highlighted the need to further explore some important issues regarding the quality of technology use. First, more research needs to be conducted to identify which technology uses are most educationally meaningful. This study used student academic outcome as an indicator for the quality of technology use. Some other outcomes are also important components of education, such as student behavior, attitude, self-esteem and career aspirations. Exploration of these aspects may enhance the effectiveness of using technology to help develop full citizens. Secondly, there is a need to explore and develop evaluation methods and instruments to evaluate student learning with technology, which is often experience-related, hidden, and difficult to assess through traditional outcome evaluation. Finally, research is needed to investigate the reasons for the popularity/unpopularity of technology uses and the conditions which favor popular technology uses, and to discover effective ways to promote technology uses that have positive impacts in schools.

References

Bruce, B. C., & Levin, J. A. (1997). Educational technology: media for inquiry, communication, construction, and expression. *Journal of Educational Computing Research, 17*(1), 79–102.

Burbules, N., & Callister, T., Jr. (2000). *Watch IT: The promises and risks of new information technologies for education.* Boulder, CO: Westview Press.

Cuban, L. (2001). *Oversold and underused: Computers in schools 1980–2000.* Cambridge, MA: Harvard University Press.

Levin, J.A., Bruce, B.C., (2001). Technology as media: the learner centered perspective. *Paper presented at the 2001 AERA meeting*, Seattle, WA.

Loveless, T. (1996). Why aren't computers used more in schools? *Educational Policy, 10*(4), 448–467.

McFarlane, A. (1997). What are we and how did we get here? In A. McFarlane (Ed.), *Information technology and authentic learning: realizing the potential of computers in the primary classroom.* London, England: Routledge.

Peyton, J. K., & Bruce, B. (1993). Understanding the multiple threads of network-based classrooms. In B. C. Bruce, J. K. Peyton, & T. W. Batson (Eds.), *Network-based classrooms: Promises and realities* (pp. 50–64). New York: Cambridge University Press.

Wenglinsky, H. (1998). *Does it compute: The relationship between educational technology and student achievement in mathematics.* Princeton, NJ: Educational Testing Service.

Zhao, Y. (2003). *What should teachers know about technology: Perspectives and practices.* Greenwich, CT: Information Age Publishing.

Jing Lei is an assistant professor of Instructional Design, Development and Evaluation program at Syracuse University. Her research interests include educational technology integration, meaningful technology use in schools, social-cultural and psychological impact of technology, teacher educational technology professional development, and international and comparative education. Her dissertation concerns how one-to-one computing influence and is influenced by teachers, students, and the school system. Her recent publications include:

Zhao, Y., **Lei, J.**, Yan, B., Tan, S. & Lai, C. What makes the difference? A practical analysis of research on the effectiveness of distance education. *Teachers College Record* (in press).
Zhao, Y., **Lei, J**., & Conway, P. A global perspective on political definitions of e-Learning: Commonalities and differences in national educational technology plans. Book chapter in *International handbook of virtual learning environments*, Kluwer Academic Publishers (in press).

Yong Zhao is University Distinguished Professor in the Department of Counseling, Educational Psychology, and Special Education at the College of Education, Michigan State University, where he also serves as the founding director of the Center for Teaching and Technology as well as the US–China Center for Research on Educational Excellence. Zhao received his Ph.D in Education from the University of Illinois at Urbana-Champaign in 1996. His research interests include diffusion of innovation, teacher adoption of technology, computer-assisted language learning, and international and comparative education. Zhao has published extensively in these areas. His articles have appeared in AERJ and Teachers College Record. He received the 2003 Raymond B. Catell Early Career Award from the American Educational Research Association. This award recognizes "a scholar who has conducted a distinguished program of cumulative educational research in any field of educational inquiry within the first decade following receipt of their doctoral degree." His most recent publications include: What Should Teachers Know About Technology: Perspectives and Practices (IAP, 2003) and Research in Technology and Second Language Education: Developments and Directions (IAP, 2005).