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Technology as a Catalyst for Change: The Role of Professional Development

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Abstract
This paper presents an analysis of results from an evaluation of The Centers for Quality Teaching and Learning, a professional development program placing technology in the context of student-centered instructional practices. This analysis focuses on the relationship between the professional development and teachers' use of technology in their classroom and their general instructional practices. The results from this study indicate teachers increased their use of technology in ways viewed as more constructivist, regardless of their broader instructional practices. One possible explanation may be the instructional context of the professional development that teachers experience. (Keywords: technology, constructivism, instruction.)

BACKGROUND

Proponents of computer-based technologies in the classroom have long argued that the use of technology can have a transformative power on teaching and learning (Sandholz, Ringstaff, & Dwyer, 1997; Office of Technology Assessment, 1995; Roschelle, Pea, Hoadley, Gordin, & Means, 2000). The use of technology in the classroom was supposed to promote more student-centered instruction and result in a shift from traditional instruction (often called "transmission") to more constructivist-compatible instruction.

Recent research has thrown this entire proposal into doubt, arguing that teachers in fact use technology in ways that are consistent with their existing instructional practices. Cuban, Kirkpatrick and Beck (2001) found little support for the idea that technology encourages teachers to transform their instructional practices. In a sociocultural analysis of three teachers, Windschitl and Sahl (2002) found that technology served as a catalyst for change in only one teacher out of the three they studied, a teacher who was already dissatisfied with her existing set of instructional practices. Zhao, Pugh, Sheldon, and Byers (2002) determined that the further a type of technology use was from existing practices, the less likely teachers were to implement it.

It is possible that both sets of researchers are correct, that technology can be used both in ways that are consistent with teachers' existing practices and in ways that shift their practices, a difference dependent upon the type of technology professional development received. According to Pierson (2001), teachers must understand how technology connects with both pedagogy and the content of the curriculum; a change in the instructional use of computers is dependent upon understanding the instructional practices needed to use technology while teaching the curriculum. Frequently, teachers' technology professional development experience is short term with a primary focus on computer skills (NCES, 2000). An inherent flaw in the design of skills-based

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technology professional development is that the focus is not on instructional practices. When teachers are provided with technology professional development focusing primarily on technical skills, they may fall back on technology uses consistent with their existing instructional practices simply because they have not been provided with an alternative vision for the use of technology. It is possible, however, that when professional development presents technology within the context of student-centered instructional practices, teachers will be more likely to change their instructional practices with their use of technology. This shift to more student-centered instruction may occur initially only whenever technology is used, creating incongruence between instructional practices used with technology and those used without technology. Therefore, this paper examines the relationship between a professional development program, teachers' instructional use of technology, and their broader instructional practices.

LITERATURE REVIEW

For the past two decades, researchers in educational technology have suggested that technology could be the catalyst for transforming teachers' instructional practices in the direction of a more constructivist approach. Constructivism is a theory of knowing. It "challenges the assumption that meanings reside in words, actions, and objects, independently of an interpreter. Teachers and students are viewed as active meaning-makers who continually give contextually based meanings to each others' words and actions as they interact" (Cobb, 1988, p. 88). In much of the literature on technology use, constructivism has been operationalized in similar ways, as explained further in the methodology section.

Researchers have argued that technology can serve as a catalyst for the changes in the content, roles, and organizational climate that are required for a shift from traditional to constructivist instructional practices (Collins, 1991; Means et al., 1993). For example, a presidential report recommended "particular attention should be given to exploring the potential role of technology in achieving the goals of current educational reform efforts through the use of new pedagogic methods based on a more active, student-centered approach to learning that emphasizes the development of higher-order reasoning and problem-solving skills" (President's Committee of Advisors on Science and Technology, Panel on Educational Technology, 1997, p. 17).

Some research has supported this perspective. For example, researchers working on the 10-year study of the Apple Classrooms of Tomorrow project found that technology changed teacher and student roles in the classroom as the students learned more and more rapidly about the technology (Ringstaff, Sandholz, & Dwyer, 1992). Of necessity, teachers ended up in a more facilitative role. Sandholtz et al. (1997), based on their Apple Classrooms of Tomorrow (ACOT) research, presented a model of instructional change containing the following five stages of technology implementation: entry, adoption, adaptation, appropriation, and invention. As teachers move through these stages their level of comfort and use of technology becomes

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more integrated and their beliefs about teaching change. Valdez et al. (1999) presented a model of three stages: automation, expansion, and data-driven virtual learning. These three stages define the way teachers structure instruction, moving from using technology as an electronic workbook, through students becoming more actively involved in searching for information, to having students engaged in authentic problem-based learning.

Although differences exist, there is consistency between these two models in that the traditional teacher-centered, transmission approach to instruction is initially reinforced with the use of technology, and then gradually replaced by more student-centered learning experiences. When teachers become comfortable with technology to the point where they can integrate it more effectively, they use it in ways that emphasize a more constructivist, learner-centered approach.

While some researchers have argued that technology can cause a shift to more constructivist instruction, others have suggested that technology can only facilitate that transition. For example, a case study of 17 teachers provided two views about technology's role in reforming teachers' practices: 1) technology prompted the emergence of more constructivist practices and 2) technology enabled a constructivist philosophy to be translated into practice. The second possibility means that constructivist instructional practices do not depend on the use of technology; rather technology may support and facilitate these practices (Ertmer, Gopalakrishnan, & Ross, 2001). Means and Olson (1995) noted in a case study of nine schools that project-based activities prompted changes in instructional roles, whether technology was used or not. Technology use was compatible with new teacher roles, with several teachers reporting that technology led them to give their students more control after they witnessed what students were able to do. The site visits and interviews supported the contention that technology facilitates the implementation of constructivist learning activities.

In a case study of 47 teachers, Dexter, Anderson, & Becker (1999) noted that the majority of teachers classified as constructivist believed that computers helped them to make the change to more constructivist practices, but computers were not the catalyst for change. Change was internal in origin with the most important factor being teacher reflection on instructional practices. In a study on microcomputers in a chemistry class, researchers found that the use of the technology had little impact on the instruction. Instead, the authors argued that a reconceptualization of teaching within a constructivist framework was necessary for effective use of the technology (McRobbie & Thomas, 2000). Results from a national survey by Becker (2001) argued that increased technology use was associated with more constructivist-compatible instruction, although the general sense was that constructivist practices came before technology use.

Researchers are then unsure about the interaction between constructivist instruction and technology use. Are there ways in which technology can serve as a catalyst for more constructivist practices? Is technology only used in a constructivist way when teachers are already engaged in constructivist-

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compatible instruction? This study examines the relationship between constructivist-compatible instruction and technology use and suggests an alternative interpretation.

METHODOLOGY

This paper uses results from a mixed methodology evaluation of The Centers for Quality Teaching and Learning (QTL™). The authors include one of the instructors in the QTL™ model during the first two years of the program and one internal evaluator. An overview of the QTL™ model and evaluation is presented first followed by a description of the data sources.

Program Description

QTL™ is a seven-day, 50-hour, intensive professional development program that models the connection between instructional practices, the curriculum, and the use of computers. The first five days of the professional development program model the classroom with teacher participants primarily assuming the role of students in a constructivist compatible, student-centered, environment. This provides the essential modeling and practice components of effective professional development (Joyce & Showers, 1995). The activities are grounded in the curriculum students study and are connected to how students learn (Cohen & Hill, 1998; Kennedy, 1999). As teachers actively participate in instructional activities that integrate educational theories and practices with the use of technology, the connection is made between technology and the curriculum (Byrom & Bingham, 1998). The last two days of the program provide the essential components of follow-up and support (Joyce & Showers, 1995; Office of Technology Assessment, 1995). The first five days can occur either during the school year or in the summer. The two follow-up days always occur during the school year. QTL™ requires that a team of three to five staff members (teachers and administrators) come from one school. During the professional development, the teachers work both as a team within their school and with members of other schools as well. Thus, an ethic of collaboration (Lieberman & Miller, 1999) is supported that enables the development of professional communities (McLaughlin & Talbert, 1993).

The QTL™ evaluation was designed to examine the implementation and impact of the program on teacher change in areas of focus explicated in the model: technical skill, awareness and use of educational theories and practices, instructional practices related to the use of computers, and general instructional practices. A complete description of the evaluation is presented elsewhere (Matzen, 2003). Data collected for the evaluation included surveys, case studies, teacher reflections, interviews, feedback on the professional development, and final teacher projects. In looking at the evaluation information it became clear that teachers reported changes in instructional practices with technology. The initial survey results showed increased use of constructivist compatible practices with the use of technology, but no increase in the general instructional practices. This paper focuses on trying to understand this difference using data collected during the first two years of QTL™ program delivery.

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Data Sources and Analysis

The data sources and their analysis procedures are designed to assess teachers' practices and use of technology on a continuum from traditional to constructivist. The operational definitions rely substantially on work done by Becker and his associates (Becker, 2001; Ravitz, Becker & Wong, 2000) and are as follows.

1. As mentioned, general instructional practices are a continuum of instructional practices from traditional to constructivist. Traditional instructional practices are more teacher-centered and didactic, with an emphasis on facts and memorization. Constructivist instructional practices are more learner-centered, interactive, and collaborative, with an instructional emphasis on understanding relationships, inquiry, and invention.
2. Instructional use of computers is a continuum of computer use from traditional to constructivist. The instructional use is associated with the respective instructional philosophy and instructional practices. With a traditional instructional use of computers the emphasis is placed on having students use technology for the reinforcement and remediation of skills. For a constructivist instructional use of computers the emphasis is on having students use technology as a tool for communication, collaboration, and accessing, analyzing, and organizing information.

The following specific quantitative and qualitative methodologies and data sources are included in this analysis:

Quantitative

A single-group, quasi-experimental, time-series design with a pre-, post-, and follow-up survey was used. All QTL™ participants were given an identical survey three times: before participating in the program, on the last day of formal intervention, and at the end of the school year. The sample for this study consists of 148 elementary educators in grades K–5 that had matched pre-, post-, and follow-up surveys during the pilot year. Of the sample, 104 were participants in the QTL™ during the summer, and 48 were participants during the fall. The survey measured participants' self-reported general instructional practices, technical skills, knowledge and awareness of educational theories and practices, and instructional use of computers in the classroom. These questions were all designed to indicate a use that was on the continuum between traditional and constructivist. The questions on the survey related to technical skill, instructional use of computers, and general instructional practices, were used with permission from the Teaching, Learning, and Computing survey (available online at http://www.crito.uci.edu /tlc/html /findings.html). Similar questions from the survey were grouped to form index scores (Cronbach's Alpha = .89). In addition to the validity study conducted with the original Teaching, Learning, and Computing survey (Ravitz, Becker, & Wong, 2000) another validity study was conducted to assess the content validity of the survey instrument specifically as it relates to QTL™. For each survey question, the

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coverage of the concept in QTL™ and the likelihood of a change in teachers' response to the question as a result of participation in QTL™ was assessed by five QTL™ adjunct instructors. As a result of the validity study, four questions were removed from the survey: two questions from the general instructional practices scale and two questions from the instructional use of computers scale (Matzen, 2003). Results from two indices, the general instructional practices and the instructional use of computers, are explored in this paper.

A Pearson product-moment correlation coefficient analysis was initially conducted to assess whether there was a linear relationship between the general instructional practices and the instructional use of computers in the classroom indices. Scores on the pre-, post-, and follow-up survey indices were also compared using a one-way repeated measures ANOVA. Follow-up pair-wise comparisons using the paired t-test were conducted to assess which means differed from each other and the False Discovery Rate procedure (Benjamini & Hochberg, 1995) was used to control for family-wise error.

Qualitative Data

To supplement the survey data, we analyzed information from two separate case studies and journal entries completed by teachers participating in QTL™. One case study was a collective case study of two schools; the other was a case study of an individual teacher in a school located in the other half of the state. The demographic information for the three schools are included in Table 1 with specific information about the data and procedures for each case study following.

Collective case study of two schools. These two schools were selected for study because both schools sought to have all of their teachers participate in the QTL™ training. In addition, the two schools were located in the same region of the state and, as indicated in Table 1, were very similar in demographic characteristics. Data collected include: (a) structured interviews with participating teachers prior to participating in the program and at the end of the year, and (b) observations in each teacher's classroom prior to participating, at least once during the year, and at the end of the school year. Each teacher also completed the survey referenced above. Data were entered in N4 and coded for presence of specific themes that related to instructional practices and use of technology associated with traditional or constructivist practices.

A case study of an individual teacher. Roberta Spaulding, the case study teacher, was part of a collective case study of three teachers who had demonstrated effectiveness with their low-performing students and who incorporated frequent use of technology in their classroom (see Edmunds, in press). A tall African-American woman with 27 years of teaching experience, Roberta had 21 students; 11 were African-American, seven were white, one was American-Indian and two were Hispanic. She started the year with seven students (one-third of her class) below grade level in at least one area and ended the year with only one student who did not pass the reading test and needed to attend summer school. Roberta was unique in that she was participating in a project that gave her access to a laptop for every student.

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Table 1: Case Study School Data

	Collective Case Study School 1	Collective Case Study School 2	Case Study Teacher School
Location	Rural	Rural	Rural
Grade span	K–6	K–5	3–5
Enrollment	172	206	665
Percent free and reduced lunch	41%	37%	65%
Percent minority	5%	3%	63%

As part of the study, Roberta participated in an in-depth, structured interview and received five full days of observations. Data analysis for this case study was more rooted in the traditions of grounded theory (Creswell, 1998). The first phase in data analysis was creation of a case study description of the individual classroom. Examining the case study, using a constant comparative approach (Creswell, 1998), one of the study's authors developed codes for teachers' general instructional practices and their use of technology. To test out the codes, the other author examined the codes and the examples. After discussion, the coding system was refined. These codes were then examined relative to the existing codes in the two whole-school case studies.

Reflections from teachers on the last day of formal intervention. Participants returning for Day 6 of the QTL™ program were asked to write a journal entry responding to the following question: "Have you changed any of your classroom practices since you had the QTL™ training?" Journal entries of 112 participants were coded based on responses in the following areas: instructional practices, understanding and use of educational theories and practices, and use of computers.

RESULTS

Survey Results

An initial comparison of the two index scores using the Pearson product-moment correlation indicated that scores on the instructional practices index and the technology use index were positively correlated, $r(112) = .391, p < .000$ This is consistent with the findings of Becker et al. (2001) who noted that more constructivist compatible instructional practices and beliefs were associated with increased use of technology for higher order applications.

To assess whether the QTL™ professional development resulted in changes in participants' general instructional practices and in their instructional use of computers, a one-way repeated-measures ANOVA was used to analyze the index score differences between participants' responses over time. The results for the general instructional practices repeated measures ANOVA indicated no significant within-subjects time effect, Wilks' $\Lambda = .990$, $F(2, 148) = .73$, $p = .48$, $\eta^2 = .01$. However, the results for the instructional use of computers repeated measures ANOVA indicated a significant within-subjects time effect,

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Wilks' $\Lambda = .775$, $F(2, 148) = 21.47$, $p < .000$, $\eta^2 = .23$. All pairwise comparisons were significant at the $p < .05$ levels.

To examine whether the changes in technology use were perhaps accompanied by a change in instructional practices that might not have been completely assessed by the survey, a Pearson product-moment correlation analysis was conducted examining the change in the pre- and follow-up index scores for the general instructional practices and instructional use of computers indices. There was a significant positive correlation between the change in general instructional practices and the change in the instructional use of computers indices, $r(91) = .354$, $p = .001$. This correlation was virtually identical to the initial correlation between the two indices, suggesting that the relationship between constructivist compatible instruction and technology use continues.

The previous results suggest that there was a relationship between QTL™ participants' general instructional practices and their instructional use of computers. Furthermore, the results indicate QTL™ participants were increasing their use of technology in ways that could be seen as student-centered. Although there was a positive correlation between teachers' general instructional practices and the instructional use of computers, there was no significant change in the general instructional practices index score. One explanation for this could be that any changes that occurred in teachers' general instructional practices may not have been substantial enough to be measured by the survey. An alternative explanation could be that any changes in participants' instruction were occurring primarily as they used the technology itself. If this is the case, participants were increasing their use of technology in student-centered ways, ways in which they had used the technology in their professional development. To better understand the relationship between general instructional practices and the instructional use of computers, the qualitative data were considered.

Qualitative Data

In exploring the relationship between general instructional practices and instructional practices with the use of computers, there were inconsistencies between technology use and instructional practices with many teachers. In classrooms that may be considered as "traditional," the participants' use of technology was often one of the few aspects of instruction that could be seen as "student-centered." Observations and interviews with the case study teachers indicated that technology could be a starting point to experiment with new instructional practices.

For example, a young sixth grade teacher in one of the case study schools described herself as "old school. I like them in rows, all doing the same thing at the same time." Observation in her classroom confirmed this description.

> All desks are arranged in rows. They have been reading the book, *Old Yeller*. I come in to the room, as they are getting ready to do vocabulary. Everyone stands up, and Debbie starts with the first student and works her way around. She gives a definition and each student has to give the word. If they don't know the word, then they have to sit down. "To make or cause a loud noise." Many

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tried and did not get that word, and the word was 'blare.' That took approximately 6 minutes. When they finish one set of words, she says, "We will go back to chapters 1 and 2." Finally she has four students that are left standing, and they all get a reward with some candy. Debbie asks, "Why did I go back?" And she says, "Because your test will have all the vocabulary words from all the chapters in it." (Field notes)

When Debbie used technology, however, she used it in ways that were different than her traditional practices. In talking about incorporating the "bio-cube," an activity modeled during QTL™, she said, "That was my one big project this year for me to do—to have the kids in different areas at different times. I have put the kids on the computers more often doing projects such as that, before it was all keyboarding."

In another classroom, Roberta, the individual case study teacher, spent a large portion of her instruction on teacher-directed, textbook-driven lessons. In her interview Roberta stated, "I mean you have to get their attention and if a child is off-task or if a child is doing, if you don't have their attention, then they won't learn. For my instruction, I ask them to be very attentive and then we go from there." Her room layout indicated the priority she placed on herself as the key way in which students gain information. The students' desks were arranged in a "U" so that everyone could see the front of the room where a table, the overhead projector, and a laptop and projector are located.

Roberta's classroom use of technology, however, provided an opportunity for her to step off center stage. In an interview, Roberta explains, "And then I look at it and there are other programs too that we could use to enhance what I'm doing and that's what I like about it because it's not just, you know, teacher, teacher, teacher. It's teacher and then I can do remedial or they can have, you know, another method of learning besides just me and interaction with me. It gives me a break and it gives me a chance to see what they are learning."

Roberta used computers instructionally in a variety of ways, as part of language arts instruction (particularly for writing and research) and as part of science instruction (researching science content). A lesson was observed in which she had students create charts, graphs, and tables from data that they collected themselves. In addition, when students used technology in her class, they were much more likely to interact with each other, providing help and feedback to their fellow students as evidenced in this description of a lesson.

> Girl 1 asks Girl 2 (the class helper) to check her Power Point "before she showed it to Ms. Spaulding." The class helper looked at it, and said, "Is that all?"
>
> Girl 1 seemed a little annoyed. The helper said, "Do you want to do something like 'In conclusion, this is my presentation' kind of thing?"
>
> Girl 1: "You can add something."
> Girl 2: "Do you know how to add a slide?"

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> Girl 1: "Duh, go to insert" and adds a slide. Then Girl 1 gets up and goes to help another girl find a Web site. She then comes back and the two of them work together on adding another slide. Both of their hands are on the computer at times. (Field notes)

Contrast this to another lesson observed without the use of technology. This lesson involved reviewing math concepts.

> Teacher: "This is one where people were very creative. Find the lowest common multiple 5, 6." One student volunteered to answer the question. He came up front. Another student said, "She didn't say come up there."
>
> Boy: "You didn't say come up here?"
>
> Teacher shakes her head. The student says, "Well, I'm up here already." She smiles and lets him do the problem on the overhead. 6.02* 2.4. Student is able to do multiplication but ran into problems placing the decimal point.
>
> Teacher: "If you get this right, but your decimal is in the wrong place, it's wrong."
>
> Teacher: "I need you to turn…" There is a chorus of moans from the students. She responds, "I love you too. I want you to do page 147, count your decimal places please. No talking." Everyone is working independently. (Field notes)

Although Roberta did have students work together when not using technology, the technology did increase the frequency and quality of interaction among the students. When the students used the technology in Roberta's classroom, they played a much more substantive role in the classroom than in a more traditional lesson.

Data from journal entries also showed that some teachers reported making substantial changes in their general instructional practices after participation in QTL™. For example, one participant wrote: "I have refocused my instruction to include a variety of teaching techniques and to empower students more." Another commented, "I think of myself as a very traditional teacher. I have started to teach and think outside the box. It is scary and exciting." A fifth grade teacher wrote: "I have changed my instructional practices. I am working on an interdisciplinary state project that has changed my role from information server to coach, helper, manager, and advisor." From the survey results, however, these changes are not widespread.

DISCUSSION

The results from this study are consistent with other research showing that the way in which teachers use technology is correlated with their instructional

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beliefs (Dexter, Anderson, & Becker, 1999; Ertmer, Addison, Lane, Ross, & Woods, 1999). Teachers who had more constructivist beliefs were more likely to use technology in more constructivist ways. Yet, our findings present a more complex picture than that, also suggesting that teachers can use technology in ways that may not be consistent with their other instructional practices, at least as when laid out on a transmission-constructivist paradigm.

The teachers in our study did increase their use of technology in ways seen as more constructivist, regardless of their broader instructional practices. One possible explanation for these results may be that when teachers see technology modeled using constructivist compatible, student-centered approaches, they are likely to use it in that way. This use of technology may or may not be consistent with their other standard instructional practices. We speculate that teachers may use technology in ways inconsistent with their general instructional practices because many see technology as a new, and somewhat unfamiliar, tool. Therefore, they tend to implement it in the ways in which they have been shown. This would also suggest that professional development experiences that merely teach technology skills would result, at the least, in no technology use at all, or at the most, in a technology use consistent with teachers' existing instructional practices, a finding consistent with Cuban et al (2001). When, however, the technology is placed in the context of a specific instructional practice, teachers may use technology to support the demonstrated instructional practice.

The QTL™ evaluation results to-date are unclear as to whether using technology in this way can serve as a catalyst for changing instructional practices in general. The results do suggest, however, that technology can provide a context or reason for trying out a new instructional practice. Additional follow-up research on teachers will be necessary to see if the continued use of student-centered practices with technology translates into using similar instructional practices without the technology.

Our findings can be seen as running counter to recent suggestions by Ertmer (2005) that "relatively simple uses of technology may be a more productive path to achieving teacher change than expecting teachers to use technology, from the outset, to achieve high-end instructional goals" (p. 33), although the overall design of the professional development is very consistent with her earlier work (Ertmer et al, 1999). Most recently, Ertmer (2005) has argued that it may be more effective to expose teachers initially to technology uses that help them more quickly accomplish straightforward instructional or process goals, such as e-mailing parents. Indeed, this may be the most appropriate way to ensure long-term success; however, our data suggest that, in the short term, teachers can use technology in ways that may be inconsistent with their instructional beliefs.

An additional explanation for this inconsistency may, in fact, result from the limitations of the transmission-constructivism paradigm. Such a dichotomy may be too simple for the "complexities and intricacies of how classroom teachers actually incorporate technology into their teaching" (Zhao et al., 2002, p. 483). It may be that additional perspectives will show that teachers' use of technology, when viewed as inconsistent from the transmission-constructivist

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perspective, may actually be seen as consistent from another perspective (e.g. Edmunds, in press).

CONCLUSION

The relationship between technology and constructivist practices is a complex one. In some situations, technology can actually promote more constructivist-compatible instruction. In other cases, it simply supports the existing instruction. Our research suggests that the interaction may depend at least partly on the type of professional development received. In addition, it is also possible that a transmission/constructivist dichotomy may not illuminate the discussion as much as people had hoped.

Our data are merely suggestive at this point. Additional research needs to be done to examine the long-term effects of professional development that models the use of technology in constructivist learning environments. Do teachers continue to use technology in this way, even if it is inconsistent with their normal practices, or do they stop using technology?

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