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Using Sociocultural Theory to Guide Teacher Use and Integration of Instructional Technology in Two Professional Development Schools

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Abstract

This article demonstrates how sociocultural theories can be used to support strategic structuring of professional development activities for preservice and practicing teachers on technology use and integration. Examples are drawn from the authors' experiences with teachers in two professional development schools that participated in a four-year Preparing Tomorrow's Teachers in Technology (PT³) project. After a review of sociocultural theory and their context, the authors describe three "activity systems" in these schools: one for practicing teachers, one for preservice teachers, and a joint preservice/practicing teacher system. Important supports for use and integration of technology built into each of these activity systems included: varied activities aimed at both beginning and advanced technology users, multiple levels of "assisted performance," and a collaborative culture that offered numerous opportunities for shared work. Lessons learned and implications for teacher educators involved in similar partnerships are outlined.

Even though evidence is mounting that instructional technology can enhance student learning and achievement (Chen & Armstrong, 2002; Chen & McGrath, 2003; Cradler, McNabb, Freeman, & Burchett, 2002; Hopson, Simms, & Knezek, 2002; Knezek & Christensen, 2002; Schacter, 1999; U.S. Department of Education, 2000; Wenglinsky, 1998), teachers often do not feel prepared to integrate newer technologies such as computer-based tutorials and simulations, virtual reality environments, interactive Web sites, two-way audio/video conferencing, digital cameras, handhelds, and telecommunications into their teaching (Cuban, 2001; U.S. Department of Education, 2001; Milken Exchange on Education Technology, 1999; Zhao & Frank, 2003). For this reason, many universities and K-12 schools across the country have joined forces in recent years to improve and support preservice and practicing teachers in their use and integration of technology, often with the support of federal funding programs such as Preparing Tomorrow's Teachers to Use Technology (PT³), Technology Literacy Challenge Funds (TLCF), and Technology Innovation Challenge Grants (TICG) (Chiero, Sherry, Bohlin, & Harris, 2003; Keller, Ehman, & Bonk, 2003; Hughes & Ooms, 2004; Mouza, 2003; O'Bannon & Judge, 2005).

What theoretical models can offer guidance in designing and sustaining these partnerships? As teacher educators who have worked for the past five years in two technology-focused professional development schools, we have found that sociocultural learning theories, based largely on the work of Vygotsky (1978), can support strategic structuring of activities in these schools without reducing the work's complexity or obscuring the unique nature of individual schools. We have also found these theories powerful because they focus on the environmental contexts in which activities are completed (Tharp & Gallimore, 1988; Wertsch, 1991).

In this article, we describe how we have used sociocultural theories as frameworks for our work with preservice and practicing teachers in two professional development schools that participated in a PT³ project funded by the U.S. Department of Education. Although professional development activities around technology use and integration have continued in these schools, the description and analysis we present here concentrates on what occurred during four years (2000-2004) of grant-funded activities.

Sociocultural Learning Theory

According to sociocultural theory, learning is socially and culturally situated in contexts of everyday living and work (Brown, Collins, & Duguid, 1989; Lave & Wenger, 1991; Moll, 1990; Rogoff, 1990; Tharp & Gallimore, 1988; Vygotsky, 1978; Wertsch, 1991). Learning is the result of a dynamic interaction between individuals, other people, and cultural artifacts, all of which contribute to the social formation of the individual mind (Wertsch, 1985) and lead to the realization of socially valued goals (Engestrom, Miettinen, & Punamaki, 1999).

Activity Systems

Activity systems (Cole & Engestrom, 1993; Engestrom, 1987; Tharp & Gallimore, 1988) offer frameworks for describing what goes on in a complex learning setting. Vygotsky (1978) described the basic elements of such a system. The "subjects," the individuals engaged in the activity, use "mediating artifacts," technical tools, symbols, language, prior knowledge, and people to help them engage in the activity and achieve a particular "object" or goal. Engestrom (1987, 1993) expands on these elements by adding "rules," which are any formal or informal regulations that constrain or liberate the activity as well as provide "assisted performance" to the subject on correct procedures and acceptable interactions to take with community members. The "community" is the social group that the subject identifies with while doing the activity. The "division of labor" describes how tasks are shared and distributed among the community. All of these elements in an activity system interact and mediate change not only for the object of the activity but also for all of the other elements—the participants, the tools, the rules, the division of labor, and the entire community (Engestrom, 1993).

Guided Participation in Zones of Proximal Development

Vygotsky (1978) maintains that learning for individuals always takes place in a social context where learners seek support from more able peers or teachers and/or technical tools or artifacts in their "zones of proximal development" (Vygotsky, 1978). Through guided participation in a shared activity within a specific context, individuals appropriate the knowledge, skills, and information needed to function within their particular sociocultural community (Putnam & Borke, 2000; Rogoff, 1990). Just as children acquire knowledge

and behaviors specific to the familial and community contexts in which they live, teachers acquire knowledge and behaviors that are a part of the context in which they teach. In each case, the number and type of activities taking place within the environment are opportunities that dictate the type and diversity of development. Therefore, to maximize the learning of many individuals within multiple “zones of proximal development,” the learning environment must be constructed as a rich and complex tapestry of activities, and there must be repeated opportunities for shared activity and access to expertise (Moll & Greenberg, 1990) by all members of the learning community. Within these multiple zones of opportunity, supports can be offered for the growth of learners at varying levels of development.

Context

Our teacher education program serves approximately 350 students in a mid-sized Midwestern private university located in the middle of a large city. Although most of our students do their field work in the city’s public schools, we had not made any systematic effort before the PT³ project began to concentrate field placements in any particular schools or with teachers who could model use and integration of technology to support teaching. When we planned this project, we were interested in moving our program in that direction by establishing a more formal partnership with two schools, supporting practicing teachers in those schools to improve their teaching with technology, and collaborating with those teachers in the education of future teachers.

We were particularly interested in partnering with Woodrow Wilson and Adlai Stevenson schools because we knew that both served a diverse population of students, were technologically well equipped, had principals who strongly supported professional development in technology, and had faculties who had set the use and integration of technology in teaching as important school goals. Furthermore, in previous activities with both of these schools, teachers had expressed interest in working with our preservice teachers and strengthening their school’s relationship with us.

With grant funds, we were able to assign a faculty liaison from the university to each of the schools for four years. The liaisons spent one day a week building relationships with practicing teachers, preservice teachers, and administrators around technology use and integration; developing links for the schools to university resources; and coordinating preservice and practicing teacher education in the school. During the grant period, each school also received funds for at least one half-time technology resource teacher who conducted workshops for practicing and preservice teachers on the use and integration of specific technological tools such as video conferencing, math and science software, Internet resources, and multimedia equipment. In addition, these resource teachers did peer coaching with individual practicing and preservice teachers on how to use these tools to meet their specific curricular objectives and standards.

Woodrow Wilson School

Woodrow Wilson School is the only public K–12 school in the city, serving approximately 760 students with 60 faculty and staff members. The mission of the school is to promote “life long learning” for both students and staff. Wilson School first became interested in partnering with our university because its principal and instructional media center director saw this partnership as a way to enhance their own efforts to encourage teachers to use newer technologies in their teaching. Their vision was to develop vanguard leaders who would be trained in the use and integration of instructional technology and would then serve as technology resource teachers, assisting other teachers in the building to use and integrate technology in their teaching. Wilson School is well equipped, with three computer labs. The main lab, located in the high school wing, has 30 iMACs and 15 PCs, each with Internet access. The lab also includes a video conferencing center and television broadcasting equipment. Adjoining this lab is a classroom with 30 older computers and printers, used largely for word processing. Another lab with 20 computers is located near the

school’s elementary classrooms. In addition, all of the school’s classrooms are equipped with at least one computer and Internet access.

In the first year of the grant project, in addition to the university liaison, Wilson School used grant funds to employ a half-time technology resource teacher from another school. During the second year of the project, faculty at Wilson asked that the resource teacher be replaced by three of their own teachers who would each serve as part-time technology resource teachers at different grade levels (K–3, 4–8, and 9–12). In exchange for providing leadership to teachers and students on technology use, the technology resource teachers were released from their classroom assignments one day a week, and grant funds were used to pay for their substitutes. That model of support continued at Wilson for three years. Now that the grant has ended, these teacher leaders continue to provide support for other teachers in the school on a more informal basis.

Adlai Stevenson Middle School

With 60 faculty and staff members, Adlai Stevenson Middle School serves 740 students in sixth through eighth grade. Stevenson’s mission is to integrate health science and technology into the curriculum. To support that mission, the school works closely with a neighboring hospital where students interact with health care professionals on a regular basis. Like Wilson, the school is well equipped with computer technology. The first floor houses a suite of labs that includes one with 30 iMACs with Internet access, a computerized science lab, a video conferencing center, and a computerized language lab with 30 computers equipped with French and Spanish software. The library media center on the third floor includes a fourth computer lab with 30 stations, all with Internet access. Additional iMACs in the media center are dedicated for research use. Each teacher has a classroom computer station with Internet access.

In addition to the university liaison, Stevenson used grant funds to hire a full-time technology resource teacher who was based in a suite of technology labs on the first floor of the school and was responsible for all practicing and preservice teacher development on use and integration of technology into the curriculum. For the four years of the project, teachers were able to work with that resource teacher throughout the day on designing classroom projects using technology, one-on-one software training (e.g. Kidspiration, Scholastic 180, PowerPoint), or training of an entire class of students in one of the computer labs.

Activity Systems as Supports for Teacher Development

Using a sociocultural lens to reflect on our planning and implementation of professional development activities at these two schools, we see two important activity systems for professional development in technology: one for practicing teachers and one for preservice teachers. We notice that at times these activity systems overlap to create a third activity system, a joint one for both preservice and practicing teachers. The object, activities, and scaffolds in these activity systems are summarized in Table 1.

The “object” or goal in all of these activity systems has been to guide teachers in the use and integration of technology in ways that enhance student learning. Practicing teachers have opportunities to learn how to incorporate more technologies in their teaching through ongoing just-in-time support, training, and peer coaching from technology resource teachers, collaborative curriculum projects, team meetings, work on the school technology committees, local/national conferences, and university graduate courses. Preservice teachers have opportunities to learn how to incorporate more technologies in their teaching through methods courses that are taught in the schools, field experiences, after-school tutoring, classroom observations of master teachers, team teaching showcase lessons with practicing teachers, student teaching, and formal and informal mentoring from school-based faculty.

Table 1. Activity Systems in Two Professional Development Schools

	Practicing Teacher Activity System	Preservice Teacher Activity System	Joint Preservice/ Practicing Teacher Activity System
Object	Use & integration of technology in teaching to advance student learning	Use & integration of technology in teaching to advance student learning	Use & integration of technology in teaching to advance student learning
Activities	Just-in-time support, curriculum projects, team meetings, technology committee work, local/national conferences, graduate courses	Methods courses, field work, classroom observations, showcase lessons, student teaching	Workshops, training sessions, peer coaching, informal conversations, videoconferencing activities, special events, team teaching
Scaffolds	Varied activities for beginning & advanced technology users; peer coaching; collaborative school culture	Varied activities for beginning & advanced technology users; peer coaching; collaborative school culture	Varied activities for beginning & advanced technology users; peer coaching; collaborative school culture

At times, the activity systems for practicing teachers and preservice teachers overlap in the area of technology learning. During the four years of the grant project, practicing teachers in both schools participated in a number of in-house workshops, training activities, and events aimed at enhancing their understanding and integration of instructional technology in the curriculum. These sessions were held on Saturday mornings, after school, and on four regularly scheduled professional development days. At these staff development programs, technology resource teachers showed other teachers how to use software programs available to them in their schools, such as AppleWorks, Kidpicks, Kidspiration, Inspiration, Trackstar, and Easy Grade Pro. Practicing and preservice teachers in both schools also attended an annual Teaching and Learning Conference held at the university, where they participated in training workshops on various computer technology applications (iMovie, desktop publishing, and content-specific software) that were integrated with curricular topics such as brain-based research and applications, literacy circles, and mathematical problem-solving activities. In some cases, this joint attendance at training sessions and special events led to joint curriculum projects. For example, a fifth grade teacher and her student teacher created a Web site for their students on the Underground Railroad, while a third grade cooperating teacher and her student teacher created one on fairy tales.

During field placements and student teaching, both practicing and preservice teachers offered each other peer coaching in areas of need. For example, a preservice teacher at Wilson helped her cooperating teacher use a computerized grade book system. Preservice teachers at both schools have helped their cooperating teachers integrate software programs such as Trackstar and Inspiration into lessons on research skills. A preservice teacher at Wilson helped her cooperating teacher use a reading assessment program so well that the teacher was later able to support other colleagues in their use of this program. Likewise, practicing teachers helped student teachers incorporate presentation software and desktop publishing into their teaching.

When the PT³ grant project ended in 2004, we found a number of ways in which we could sustain the practicing teacher activity systems. In place of the grant-supported faculty liaisons, faculty supervisors who regularly visit student teachers assigned to these schools serve as a conduit for information to the school faculty and administrators about learning opportunities at the university and to university faculty about professional development needs at the schools. At Wilson School, three teacher leaders, who assumed faculty support roles with the help of the grant, continue to provide onsite support for practicing and preservice teachers at various grade levels. When science faculty in both schools expressed a need for more help in using technology to support inquiry-based lab activities, we connected seven science teachers from the two schools to a new grant-supported two-year professional development project with our university's Physics Department and School of Education. In addition, we connected a team of fine arts teachers at Wilson School to a professional development project at a local art and design school that shows teachers how to integrate technology in the teaching of art. Finally, we are making

plans to conduct onsite and online graduate courses for teachers at both schools who have expressed interest in a master's degree.

The activity system for preservice teachers did not change significantly with the end of grant funding. Our student teachers are regularly placed in their methods field work and student teaching with practicing teachers in the schools who were trained and supported in technology use and integration during the grant period. In addition, a Wilson School faculty member has been hired to teach our middle school methods course. She is connecting her preservice students to the school's students, faculty, and resources through videoconferencing and classes held at the school. Another Wilson middle school teacher is now working closely with our science methods instructor to develop more joint science activities between her middle school students and university preservice methods students. Similarly, the joint activity system for both preservice and practicing teachers still exists as they continue to interact through peer coaching, informal conversations, videoconferencing activities, and team teaching.

Supports for Use and Integration of Technology

Using a sociocultural lens, we have been able to identify several critical features in these activity systems that seem to encourage professional development in technology use and integration for preservice and practicing teachers: (1) varied activities aimed at beginning and advanced technology users, (2) multiple levels of "assisted performance," and (3) a collaborative culture that offers numerous opportunities for shared work.

Varied activities aimed at both beginning and advanced technology users

According to Vygotsky (1978) and other sociocultural theorists (Gallimore & Tharp, 1990), individuals in any social setting are going to be at different stages of "proximal development." That is, they will have different needs for activities that will challenge them to grow and develop, and they will also have different needs for support. We knew from surveys during the first year of our project, as well as from informal conversations with technology resource teachers, that practicing and preservice teachers at both schools varied in their knowledge, experience, and use of instructional technology. For this reason we developed and implemented a variety of technology activities for both beginning and advanced technology users in after-school training sessions, regularly scheduled professional development days, and coursework at the university.

During after-school training sessions, teachers at beginning levels of technology use worked with the technology resource teachers to learn how to use applications such as AppleWorks and Kidspiration, how to develop a computerized grading system, how to use a spreadsheet, or how to use videoconferencing equipment. These training sessions typically presented technology in a direct instruction format, after which the technology resource teacher worked with the teachers as they implemented applications in the classroom. For teachers more advanced in technology use and

integration, training activities scheduled during the regular professional development days focused on more complex uses of technology: creating Web sites, developing iMovies, using Trackstar for student research, and integrating multimedia in teaching. In addition, these more advanced users have been offered opportunities to take online graduate courses in technology integration and to develop advanced technology and mentoring skills at local and national technology conferences. In a new project for science teachers at both schools, beginning and advanced users are learning how to integrate a variety of technologies in their teaching of science, including Vernier software, electronic sensors and probes, and computerized calculators, handhelds, and whiteboards.

Multiple levels of "assisted performance"

A critical element in learning, according to sociocultural theorists, is "assisted performance" (Moll & Greenberg, 1990; Rogoff, 1990; Tharp & Gallimore, 1988). That is, while students are in their "zones of proximal development" (Vygotsky, 1978), they can access the help and support of more able peers or a teacher to perform certain tasks. The help given is not merely directive and evaluative but is designed to scaffold learners through a combination of modeling, feedback, direct instruction, and questioning to a point where they can independently perform the tasks that previously required assistance.

During the PT³ grant period, the work of the technology resource teachers illustrated how this "assisted performance" operated in these schools. Typically, their one-on-one support of teachers began with a consultation to determine a teacher's level of use and comfort with technology and what kind of assistance the teacher needed. For example, with one Stevenson science teacher, who was a novice technology user, the resource teacher began her assistance by simply showing her how to use the CD-ROM that came with the science textbooks. When the teacher was able to use the CD-ROM on her own and teach her students to do the same, the resource teacher then worked with the science teacher on how to incorporate more Web-based resources into her science teaching. She also helped her develop a system that computerized all of her quizzes, tests, and grading. Within a couple of years, this teacher, now "a more able peer" (Vygotsky, 1978), became a school leader in her use and integration of technology and was assisting other teachers in their efforts to incorporate technology in their teaching.

For some teachers, who had a higher comfort level with technology, the resource teachers' assistance was often more informal. For example, the technology resource teachers at Wilson could frequently be seen before and after school or during lunch giving a teacher a quick "just-in-time" training lesson on topics such as: how to make a computerized poster, how to import a graphic into a PowerPoint presentation, or how to use a handheld device to track student progress. For teachers who needed more formal assistance in implementing technology in their teaching, the technology resource teachers in both schools set up a schedule where teachers signed up to discuss integration possibilities such as: desktop publishing for story writing in language arts, Web-based resources and animation in science, newsletter publication in social studies, and online course development for middle and high school students. Initial discussions about such activities typically led to some team teaching where the technology resource teacher went into a computer lab with a teacher and her/his class, modeled the teaching with technology and then gradually "released responsibility" (Rogoff, 1990) to the developing teacher to use the technology in her/his own teaching.

The technology resource teachers in both schools worked hard to make the logistics of incorporating technology into teaching easier for individual teachers. At Stevenson, the technology resource teacher borrowed a set of laptops from the school district so that a teacher could implement an Internet research project in her own classroom. The resource teachers spent time setting up software systems on computers so

that teachers didn't have to spend the time themselves and would thus be more inclined to use these tools. For example, a teacher at Stevenson wanted to connect with a district-wide math program. To facilitate that, the technology resource teacher set up the lab for the teacher so that the teacher could simply take her students into the lab, sign on, and begin the work with her students.

A collaborative culture that offered numerous opportunities for shared work

Because sociocultural theory maintains that all learning is "assisted performance," it follows that to learn new ways of teaching with technology, teachers need to constantly be in situations where they can access the guidance of more able peers who can mentor and coach them in their "zones of proximal development." Instead of fostering a culture of isolation (Lortie, 1975), schools need to foster a culture of collaboration, a place where school personnel "share common goals, work at relevant instrumental tasks, and interact in particular ways that reduce anxiety, encourage persistence in the face of difficulty, and employ all the means of assisted performance" (Tharp & Gallimore, 1988, p.191). Such a social context provides a continuum of learning opportunities and support for community members with differing levels of expertise. Without a sharp division between expert and novices, all are able to assist others in their own areas of competency but also find assistance in their own "zones of proximal development" (Tharp & Gallimore, 1988; Vygotsky, 1978).

Such a "community of practice" (Lave & Wenger, 1991) or what Scardamalia and Bereiter (1996) call "knowledge-building communities," can be developed when a school or university intentionally creates a rich array of formal and informal opportunities for preservice teachers, practicing teachers, and university teacher educators to jointly participate in professional development activities and projects. Recent accounts in the literature of such intentional learning environments aimed at the professional development of preservice and/or practicing teachers have included reports of collaborative inquiry groups (Hughes & Ooms, 2004); online master's programs (Levin, Waddoups, Levin, & Buell, 2001); online forums and discussions (Bonk, Ehman, Hixon, & Yamagata-Lynch, 2002; Brett, Woodruff, & Nason, 2002; Whipp, 2003); collaborative curriculum development projects (Grossman, Wineburg, & Woolworth, 2001; Kahne & Westheimer, 2000); and collaborative practitioner research (Crocco, Faithfull, & Schwartz, 2003; Levin & Rock, 2003; Loughran, Hamilton, LaBoskey, & Russell, 2004).

During the four-year project, professional development in technology at Wilson School seemed to move toward such a community of practice. Teacher development in technology there moved from a disparate collection of activities that teachers did in isolation to a culture that offered frequent opportunities for shared work around technology use and integration among school administrators, practicing teachers, preservice teachers, and teacher educators. During the first year of the project, in addition to collaboration that was fostered in the training workshops and peer coaching activities described earlier, a developing culture of collaboration was evident as teachers at Wilson planned and implemented their first Kid Conference, a two-day program where students from the school demonstrated various computer activities and programs to other students and teachers at Wilson and neighboring schools. This conference has continued as an annual event.

During the second year of the project, in grade level meetings, all-school meetings, and informal conversations among the university faculty liaison and school faculty members, it became evident that a number of teachers at Wilson School were beginning to share ideas on technology integration and to collaborate on classroom activities and projects. For example, a high school and elementary school teacher used publishing software with their students to write and publish a series of children's storybooks that incorporated high school student research on children's

authors and elementary student illustrations and graphics. Also in the second year, university teacher educators, practicing teachers, and the technology resource teachers in the schools began several collaborative projects that employed videoconferencing. A middle school methods class used videoconferences with some of the school's teachers to discuss classroom management issues. Videoconference sessions brought together Wilson's technology resource teachers, Wilson students, and faculty and staff from the university to share technology integration ideas. The technology resource teachers and students from both Wilson and Stevenson used a videoconference to come together weekly for a Harry Potter Book Club. Teachers at both Wilson and Stevenson also used videoconferences to collaborate on developing lessons for their students who incorporated videoconferencing tools. During the third year of the PT³ project, all of these activities were continued and enhanced. In addition, during the third year the university faculty liaison, teachers, and the principal at Wilson School did a joint presentation on their collaborative activities at the National Educational Computing Conference (NECC).

Throughout the life of the project, university teacher educators, the principals in both schools, and teachers also collaborated on equipment purchases and training. For example, in the last year of the project the principal at Wilson agreed to purchase a classroom set of AlphaSmarts and Dana Digital Assistants in exchange for university-sponsored training of a core group of practicing and preservice teachers on how to use and integrate these tools into their classroom teaching. This core group then made plans to train other practicing and preservice teachers on the use of these tools in future years.

Lessons Learned

At the end of our PT³ project, we knew that more teachers in both schools were using technology in their teaching. We also knew that more of our preservice teachers were having the opportunity to practice using technology in classrooms where its use in teaching was valued and modeled. But we also had concerns. In one school, teacher turnover was high, and newly hired teachers were not always ready to embrace the technology initiatives that were developed with the PT³ project. Some veteran teachers in both schools were also reluctant to use newer technologies in their teaching, particularly because they were feeling greater pressure to raise student scores on standardized tests. In fact, at Stevenson, administrators began pushing math teachers to use a quick-fix mathematics software program designed to raise test scores rather than teach for mathematical understanding, a use of technology that we did not want our students to emulate. Some teachers at both schools were not sure how to mentor preservice teachers in technology use and integration. Finally, but perhaps most importantly, the effect of increased technology use and integration on student learning and achievement in these schools was unclear.

Implications for Teacher Educators

As we reflect on these successes and concerns, we offer these steps to other teacher educators who are looking for ways to effectively plan and sustain university-school partnerships focused on teachers' professional learning in technology use and integration:

1. **Plan partnerships with schools that already have sufficient hardware and hardware maintenance capacity so that access issues are minimal.** If grant funds are available, use them to build an infrastructure for overlapping practicing/preservice teacher activity systems and plan how they can be maintained after grant funding has ended.
2. **Plan partnerships with schools where there is a shared vision about student learning or the potential for one.** Sociocultural theorists argue that an important aspect of a thriving social learning environment is joint activity that is goal directed, with goals that are local, valued, and shared (Rogoff, 1990). Discussions with

practicing and preservice teachers in both schools indicated that although both schools had stated goals of improving education for all children and of improving technology use and integration, neither school faculty had fully clarified how technology use and integration related to the broader goal of student learning. Furthermore, neither school had a clearly articulated scope and sequence for student knowledge and skills in technology. We now realize that we need to take steps to ensure that all members of the school community share a common definition of the learning goals that technology use supports and that there is an assessment system in place to measure the kind of student learning that is being supported through technology use and integration.

3. **Plan for dynamic systems of activity that maximize the sharing of expertise.** Sociocultural theory suggests that overlapping systems of activities for preservice and practicing teachers will more strategically and richly support those teachers in their use and integration of technology in teaching than will the use of isolated professional development activities. In our professional development schools, we now know that we need to be more systematic about investigating the developmental levels and readiness of both preservice and practicing teachers to use and integrate technology. We need to better establish a "division of labor" (Engestrom, 1987, 1993) so that professional development activities in technology might be more strategically shared and distributed among members of the school community who have varying levels of expertise and experience with technology. A step in this direction at Wilson was the assignment of three faculty members who serve as onsite technology resource teachers to teachers at three different grade levels. These roles and assignments have continued even though the grant period has ended. Similar onsite support has not been available at Stevenson after the grant funding ended. We also realize that the newly created activity systems for practicing and preservice teachers in these schools have not consistently included other important members of these learning communities—administrators, staff, students, parents, and teacher educators. Activity systems (with clear goals, activities, and opportunities for assisted performance) for all of these groups would offer even greater opportunities for various stakeholders to collaborate and learn from each other.
4. **Pay attention to both supports for and constraints on the activity systems.** We have identified a number of supports that developed in these schools for professional development in technology integration: varied activities for beginning and advanced technology users, peer coaching, and a collaborative school culture. During the project, however, we also became aware of a number of reasons why teachers were reluctant to use and integrate technology in their teaching: time constraints, classroom management problems, and lack of convenient access to technology equipment. Such obstacles need to be identified and addressed early with strategies that can include: release time for preservice and practicing teachers to observe others who effectively use and integrate technology, professional development activities that address classroom management issues in connection with technology use, increased peer coaching, team teaching, increased use of portable technological tools, and more participation of administrators, university teacher educators, parents, and community members in classroom work.
5. **Work on building an intentionally collaborative school culture.** Sociocultural theorists argue that learning is not an individual activity but that it is "distributed" among the people and tools of a learning community. Furthermore, the collaboration and learning that occurs in such a community is "intentional"; it is consciously aimed at and planned. At Wilson, we see the power that such a culture has in scaffolding learning for both preservice and practicing teachers. Sociocultural theories can provide useful frameworks for planning

and strategically structuring activities that will help both preservice and practicing teachers use technological tools in powerful ways that support student learning. They can also provide a basis for reflecting on whether such activities are effective, how they might be improved, and how they can be sustained within the complex environment of a professional development school.

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