Promoting Technology Integration Through Collaborative Apprenticeship

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Teachers often learn technology skills and integration strategies in intensive seminars, ineffective means for professional learning because experiences are seldom transferred to instructional practices. Thus, effective technology integration requires teachers to obtain learning experiences within the context of their teaching so they can practice, reflect, and modify their practices. Learning in a teaching community is a social process that involves ongoing, on-site, and just-in-time support. Teachers need avenues to continually interact to provide such support across all members of the community. Collaborative Apprenticeship, a professional development model featuring reciprocal interactions, is one such approach to promoting technology integration. Teachers experienced in technology use serve as mentors of peer-teachers' technology applications aimed at improving instruction. Technology is progressively infused as peer-teachers learn to design technology-rich lessons from their technology-savvy peers through modeling, collaboration, and coaching.

Instructional technology, "the theory and practice of design, development, utilization, management, and evaluation of processes and resources for learning" (Seels & Richey, 1994, p.1), is rarely well integrated into classroom practices (CEO Forum on Education and Technology, 1997). Several factors have contributed to this state of affairs. School districts typically spend far less on training and support than on hardware (Means & Olson, 1997), so technology integration efforts are often compromised. Ineffective teacher in-service programs also contribute to this trend (Office of Technology Assessment, 1995). Practicing teachers often learn about integrating technological tools outside of their classroom environment during summer or weekend workshops, and have only limited opportunities to apply and evaluate what they have learned. When learning is not situated in authentic environments, knowledge and skills tend to become more abstract and less meaningful (Brown, Collins, & Duguid, 1989). Consequently, when teachers return to their classrooms, efforts are often unsuccessful, because of a lack of practical opportunities and experience integrating technology in *their* instructional settings to address *their* instructional needs.

This problem is compounded by the changing nature of teachers' responsibilities, which have become increasingly complex and time consuming. Teachers often have little time available to troubleshoot technical difficulties or sift through manuals to acquire basic software skills (OTA, 1995). Indeed, teachers who are unsuccessful initially seem to become discouraged quickly, tending to abandon the technology

innovation citing lack of support to sustain their efforts (Guhlin, 1996; Schrum, 1999). Simply making technological tools available and offering training rarely improves or increases technology integration (i.e., strategic design of instruction using technological tools); it may be necessary, but it is clearly not sufficient. Professional learning needs to be well-organized and include opportunities to explore, reflect, and support—processes especially important to integrating technology seamlessly, efficiently, and effectively (Hunter, 2001).

Teachers tend to devote needed effort to integrate technology in their classrooms when they recognize positive effects with their students; they are then, in turn, more likely to sustain and enhance their efforts (Holahan, Jurkat, & Friedman, 2000). In order to develop effective and innovative approaches, teachers need ongoing, sustainable support to ensure their value (Honey & Henriquez, 1993; OTA, 1995; Schrum, 1999). Unfortunately, ongoing support is rarely provided during the school day in typical teaching settings.

One way to both increase teacher motivation and provide ongoing support is to form community-wide goals where peers support each other's learning. Hausman and Goldring (2001) found that teachers are most committed to their schools when they have a sense of community and are offered opportunities to learn. Effective support requires ongoing interactions, where peers discuss and learn from classroom successes and failures (Boyd, 1992). Innovative ideas are shared, and more important, strategies emerge across community members through collaboration. In essence, a strong collegial environment is needed to integrate technology effectively, where teachers share ideas, model best practices, ask difficult questions, and support one another where and when it is most needed.

The Collaborative Apprenticeship, a professional development model situated in the context of the school environment (see Glazer & Hannafin, in press), has the potential to increase the quality and frequency of technology integration. Teachers obtain on-site, continual, and just-in-time support from peers as professional learning is integrated into the community's repertoire. The model utilizes the intellectual resources and skills of a teaching community through mentoring partnerships whereby novices learn as apprentices from experts' modeling, coaching, and fading—major characteristics of apprenticeships (Collins, Brown, & Newman, 1989). In contrast to the discrete learning experiences of workshops, teachers provide continuous support to their peers during the school day in order to monitor growth and improve their design, development, and implementation of effective practices.

In this article, we present the Collaborative Apprenticeship framework, describe an application to improve technology integration by cultivating professional teaching communities in school environments, and identify implications for promoting situated professional development.

BACKGROUND

The Collaborative Apprenticeship model draws from both Collins et al.'s (1989) notion of a cognitive apprenticeship and collaboration concepts from Communities of Practice (Wenger, 1998), applying them in the context of technology integration in K–12 educational settings. In essence, collaborative apprenticeships situate teacher learning and performance within professional teaching communities.

Cognitive Apprenticeship

Several studies have demonstrated the value of cognitive apprenticeships to support and enhance teaching (Cash, Behrmann, Stadt, & McDaniels, 1996; Chyung, Repman, Lan, & Winiecki, 1997; Glazer, 2004; Snyder, Farrell, & Baker, 2000). Collins et al. (1989) proposed a cognitive apprenticeship model to support teaching and learning in reading, writing, and mathematics. Novices learned to solve problems and handle complex tasks through modeling, coaching, and fading. Initially, novices observed experts modeling the target process. Novices then executed the task themselves, with experts (e.g., teachers) coaching and scaffolding on the side. As novices became more proficient, the inten-

sive coaching of experts was faded to occasional feedback.

Duncan (1996) described a cognitive apprenticeship approach for teaching writing in a community college. Instructors, as expert writers, initially modeled the writing process using a think-aloud approach to share their writing strategies and processes, describing what they were thinking and the rationale for their actions, and verbalizing their self-correction processes. After modeling, students initiated their own writing process while instructors explained the writing principles and rules, thereby scaffolding student learning to a certain writing style. As students gained experience in writing, instructors withdrew assistance gradually. Ultimately, students developed self-sufficiency and expertise in their own writing.

Community of Practice

In communities of practice, members participating in peripheral roles and central roles work together to learn and share social practice (Wenger, 1998). Community participation involves social, reciprocal negotiation to explore meaning and share understanding among members. Through reciprocal interactions, mutual exchanges occur between learners and teachers—"the learner and the teacher are learning from each other, as well as giving affective responses to each other's demands" (Chene & Sigouin, 1997, p. 253–254). Such exchanges are fundamentally engrained in the everyday activities of a community of practice (Wenger), helping to overcome or mitigate barriers through mentor-apprenticeship collaborations while strengthening relationships between experienced and novice professionals. The interactions serve to distribute both knowledge and strategies across the community.

Three community of practice constructs are central to Collaborative Apprenticeships: (a) mutual engagement, (b) shared repertoire, and (c) joint enterprise. Through *mutual engagement,* teachers influence the selection and progression of community activities through equal representation, designing and developing learning activities, making curricular decisions, and leading and/or following their peers in different initiatives. *Shared repertoire* describes common experiences across community members. In a teaching community, shared repertoire embodies *knowing* what it feels like to be a teacher, and being able to relate to other teachers quickly because of common responsibilities, shared language, and the emotional impact of teaching children and adolescents. *Joint enterprise* involves common principles to which a community adheres, and the common goals toward which it strives. In teaching communities, joint enterprise reflects the mutual investment of teachers in various initiatives, such as adopting instructional resources, developing shared curriculum, and learning new strategies and skills for the benefit of all teacher.

THE COLLABORATIVE APPRENTICESHIP MODEL

Collaborative Apprenticeship, an extension of Collins et al.'s cognitive apprenticeship (1989), is a professional development model designed to support teacher learning in their professional teaching community during the school day. Collaborative apprenticeships feature reciprocal interactions between peer-teachers and teacher-leaders (Glazer & Hannafin, in press). Novice teachers gradually evolve from the role of peer-teachers into that of teacher-leaders by moving through the four progressive phases of the model.

Situated in a community of practice that fosters reciprocal interaction, mutual engagement, and shared enterprise (Wenger, 1998), teachers receive on-site support, in-time training, and continuing training. The reciprocal interactions between peer-teachers and teacher-leaders characterize the unique relationships and flow between and among practitioners of the Collaborative Apprenticeship model. During the initial stage, the interactions between teacher-leaders and peer-teachers are intense. As peer-teachers become more proficient in technology-integration skills, and thus more autonomous in technology-integration practice, the interactions decrease gradually, eventually fading completely. As a result, more peer-teachers become

teacher-leaders, building the collective repertoire of the community.

Phases

Whereas cognitive apprenticeships emphasize modeling, coaching, and fading (Collins et al., 1989), collaborative apprenticeships comprise four progressive phases: (a) introduction, (b) developmental, (c) proficient, and (d) mastery (see Table 1). The *introduction* involves a teacher-leader mentoring peers as well as establishing shared goals (Keedy, 1999). Unlike modeling in a cognitive apprenticeship, where novice learners observe experts executing target tasks (Collins et al.), teacher-leaders and peer-teachers work collaboratively during the *developmental* phase, designing, developing, and implementing learning activities using new instructional strategies or resources. The *proficient* phase is similar to the coaching stage in cognitive apprenticeship, where peer-teachers develop learning activities independently with on-site support from teacher-leaders. The *mastery* phase is similar to fading in cognitive apprenticeships. Expert (teacher-leader) coaching is faded gradually into feedback as peer-teachers become increasingly skillful and capable. However, the collaborative apprenticeship also emphasizes the importance of supporting teachers to become mentors (teacher-leaders) in their community of practice. Support, in collaborative apprenticeship, is both ongoing and distributed throughout the community.

Principles

The Collaborative Apprenticeship framework features several important similarities to and distinctions from cognitive apprenticeship. As with cognitive apprenticeships, experienced teachers mentor their less experienced peers, modeling, scaffolding, and coaching until they become autonomous in the design, development, and implementation of key practices. In collaborative apprenticeships, teachers also

Table 1 ☐ Phases and roles to promote collaborative apprenticeships for technology integration in teaching communities.

Technology Integration Phase	*Teacher-Leader Roles*	*Peer-Teacher Roles*	*Collaborative Partnership*	*Related Sources*
Introduction	Promotes and models use of technology in workshop or classroom environments	Observes and participates in learning applications of technology	Discusses and reflects on learning and design experience	MacArthur et al., 1995; Putnam & Borko, 1997, 2000; Smith & O'Bannon, 1999
Developmental	Provides scaffolding, coaching and fading to design, develop, and implement learning activities	Acquires software and design skills in context of participation	Collaboratively designs, develops, and implements technology-enhanced learning activities	Holahan, Jurkat, & Friedman, 2000; Kariuki, Franklin, & Duran, 2001; Swan et al., 2000
Proficiency	Identifies areas for improvement and exploration	Articulates understanding by autonomously designing activities	Shares experience and ideas with peer community	Browne & Ritchie, 1991
Mastery	Observes and participates in learning applications of technology	Promotes and models use of technology in workshop or classroom environments	Peer-teacher becomes teacher-leader for design and development of learning applications	Caverly, Peterson, & Mandeville, 1997

challenge existing ideas and contribute to the professional resources available to the collective. Teachers learn from and respond to each other's needs through interaction opportunities, such as shared planning, providing support that is on-site, ongoing, and just in time. Unlike cognitive apprenticeships, where knowledge and skills are transferred from experts to novices, collaborative apprenticeships emphasize the collaboration and mutual benefits derived by both teacher-leaders and peer-teachers when building a community of practice. In collaborative apprenticeships, for example, peer-teachers assume the role of teacher-leaders as they become increasingly knowledgeable and skillful, thus forming a cyclical relationship with other community members. As members gain experience and knowledge, they contribute to the collective resources of the community; that is, all members benefit from the fruits of their shared repertoire.

Collaborative apprenticeships provide opportunities to observe effective practices as well as on-site, just-in-time support, and ongoing training (Byrom, 1998; Holahan et al., 2000). Consistent with situated learning perspectives, teachers observe and experience effective practices in their schools because "learning and cognition are fundamentally situated" (Brown et al., 1989). Concrete examples help teachers to develop instructional ideas and reflect on a situated experience—their "theory in practice" (Lave & Wenger, 1990). Modeling enables teachers to observe one another in real classrooms, to better understand the learner perspective as well as to reflect on the experience, provide feedback to the teacher, and develop their own strategies (Manouchehri, 2001).

With collaborative apprenticeships, teachers receive on-site support to develop comfort and confidence as they become increasingly capable. Because teachers may become unduly dependent on external support, however, collaborative apprenticeships focus on skills and strategies that ultimately enable the teacher to perform autonomously. Teachers use each other, as well as other external supports, to improve their understanding and use of technology. Classroom proximity and common curriculum facilitate mutually engaged, shared learning experiences that lead to reciprocal and joint participation.

During collaborative apprenticeships, teachers receive just-in-time assistance; that is, support on demand. In professional and situated environments, learning becomes most meaningful and relevant when it is necessary to complete a task (Brown et al., 1989). During the school year, teachers tend to tailor their lessons and professional learning directly to their instructional needs, addressing curriculum issues and student learning. For example, during everyday classroom activities teachers may understand the value and necessity of using geometry software to visualize the relationship between the position of an altitude and the angles in a triangle. In contrast, summer or "pull-out" workshops tend to isolate or compartmentalize knowledge, skills, and activities because often they are not situated in an authentic context. Lacking an immediate application context, they typically have little impact on classroom practices (Schrum, 1999). Or, teachers may not recall their workshop experiences or fail to recognize their applicability to classroom needs—a classic "inert knowledge" transfer dilemma. With just-in-time learning, teachers have the opportunity to develop ideas and learn from peer-teachers who currently teach the same concepts in the same settings.

Finally, in collaborative apprenticeships, rather than single seminars or workshops, teachers receive ongoing training, in order to develop their understanding of technology integration (Schrum, 1999). Although teachers need progressively more challenging opportunities to extend their facility to teach with technology, workshops typically decontextualize uses of technology. Although improving tool facility, they give few opportunities to try out and evolve approaches consistent with both individual teacher needs and the unique situational demands of the classroom. In collaborative apprenticeships, opportunities are provided to reflect on experiences after initial implementation so teachers can act on their specific needs and situational demands. This support occurs in everyday school contexts where teachers and students interact during shared time and space.

APPLICATION OF COLLABORATIVE APPRENTICESHIP MODEL IN TECHNOLOGY INTEGRATION

In typical settings, both technology integration skills and mentoring experience vary widely: A few teachers tend to have greater experience and expertise while most have less experience and technology integration expertise. Initially, it is essential to identify the most capable (and motivated) to assume the responsibilities of teacher-leaders. The remaining teachers, those less experienced in and familiar with integrating technology in their teaching, assume peer-teacher roles. In the following sections, we describe an application of the Collaborative Apprenticeship model in a K–5 school setting, citing evidence from research on the model's implementation (Glazer, 2003).

Introduction Phase

The introduction phase follows the initiative of a community of practice's sharing of a common goal—to learn and develop innovative technologies (Norum, Grabinger, & Duffield, 1999). Teachers need to express interest in learning to use and improve technology integration in their classrooms. In Glazer's (2003) study, the introduction required a total of 8 weeks. During this phase, a teacher-leader modeled how tools, such as Internet for information gathering, Inspiration® for writing, and Math Keys® for mathematics, can be used in lessons. In addition, they shared and explored strategies to create lessons with the tools during departmental meetings, a common planning period, or an in-service workshop. Peer-teachers observed teacher-leaders modeling activities, discussing the skills and strategies needed to design and develop their own technology-integration activities. The modeling stimulates interactions that support community learning, while making visible the cognitive processes of a community expert. Further, through authentic classroom activities, peer-teachers observe and learn technology applications related directly to *their* instructional practices (Putnam & Borko, 1997). Modeling can be extended to observations within teachers' classes. Kariuki, Franklin, and Duran (2001), for example, stimulated technology integration by having mentors teach other teachers' classes, providing the teachers with opportunities to observe how *their* students learn from technology, while simultaneously becoming increasingly comfortable with technology tools.

Developmental Phase

Teachers initially transform their roles during the developmental phase, where collaboration is essential in the design, development, and implementation of technology-enhanced learning environments. During Glazer's (2003) study, for example, peer-teachers worked in teams of two or more to design a technology-enhanced lesson, such as using Inspiration to help students organize their writing, under the guidance of the teacher-leaders. The collaboration occured initially during planning meetings, where peer-teachers met to brainstorm the design, development, and implementation of technology-enhanced learning activities: Teacher-leaders scaffolded peer-teacher efforts rather than directing them explicitly. That is, the focus of activity shifted from modeling typical during the introduction phase to mutual engagement. Teacher-leaders worked closely with peer-teachers as they developed activities, advising but gradually relinquishing responsibility during the design process. Teacher-leaders coached peer-teachers until they gradually became independently able to develop original ideas and enact their own technology-rich lessons. As peer-teachers assumed greater responsibility, the planning meetings shifted from the whole group to small teams. Using journals, peer-teachers reflected on technology integration experiences in their classrooms; teacher-leaders reviewed the reflections and help to refine development plans for individual teachers as well as the overall community.

Proficient Phase

During the proficient phase, peer-teachers utilized strategies learned and refined during the introduction and developmental phases, creat-

ing technology-enhanced lessons without the direct tutelage of teacher-leaders. Responsibility shifted from teacher-leaders to peer-teachers in order to demonstrate the latter's ability to create technology-rich lessons without continued support from or dependence on teacher-leader scaffolding. Initially, small teams of peer-teachers worked collaboratively to design individual activities or lessons. Peer-teachers could still seek advice from teachers in other teams and discuss progress with them. The teacher-leader was not removed from the partnership, but instead evaluated the peer-teachers' work and provided alternatives for lesson activities. For instance, teacher-leaders examined how technology was used to enhance learning, which curriculum standards were supported, and related issues relevant to the community. During the latter stages of the proficient phase, each peer-teacher independently developed a teaching-learning technology integration lesson plan that was subsequently shared with the community for future implementation.

Mastery Phase

During mastery, peer-teacher participation becomes more central than peripheral (Lave & Wenger, 1990). The initial set of peer-teachers, with newly developed knowledge, skill, and confidence in their ability to independently design, develop, and implement technology-enhanced lessons and activities, assume the roles and responsibilities of teacher-leaders: The Collaborative Apprenticeship professional development cycle becomes self-sustaining. Using a related approach, Caverly, Peterson, and Mandeville (1997) found that first-generation mentors supported the development of a peer-teacher's technology integration until the peer was able to mentor another teacher. By the third generation of mentors, all teachers in the teaching community had mastered the requisite strategies and skills. In essence, the technology integration capabilities of a teaching community are sustained when knowledge and skills are distributed across members and responsibilities are share across the community. Each teacher assumes a different leadership role based on situational demands and domains of expertise. An individual with expertise in electronically generated writing may serve as a teacher-leader for that area, while serving as a peer-teacher in an unfamiliar area such as on-line research. As a consequence, teachers develop multiple avenues for professional learning when they mutually engage in, and take responsibility for, their peers' development (Palinscar & Brown, 1984).

IMPLICATIONS OF THE COLLABORATIVE APPRENTICESHIP MODEL

The implications of the Collaborative Apprenticeship model for technology integration are three-fold: (a) building communities of practice for teachers at schools; (b) developing strong leadership on technology integration; and (c) supporting teacher empowerment. Once applied in schools, the Collaborative Apprenticeship model helps to build a community of practice among teachers integrating technology, which, in turn, enhances the impact of the model in practice.

Building Communities of Practice for Teachers

Lack of collaborative culture is commonly cited as inhibiting the integration of technology in classrooms (see, for example, Parr, 1999); communities of practice may help to foster productive collaborations (Lave & Wenger, 1990). Members master knowledge and skill by participating in communities of practitioners where newcomers move from peripheral to full participation in the corresponding sociocultural practices (Lave & Wenger). No "single core or center" exists for a community of practice, but many centers emerge to support different knowledge and skill needs of the community (Lave & Wenger, p. 36). Through legitimate peripheral participation, newcomers gain access to expert practices through progressive involvement. The roles in the community change constantly as teachers move from peripheral to full participation. Teachers can be teacher-leaders in one area, but at the same time are peer-teachers

in another area, thus promoting a collaborative culture among teachers.

Collaborative apprenticeships may also help to strengthen the teaching community as a joint enterprise with shared repertoire. They help to promote mutual engagement through reciprocity because roles and responsibilities of teachers are akin to those of a community of practice. One teacher in MacArthur et al.'s (1995) study on computer mentoring, for example, described this evolution as a progression of guiding, coaching, encouraging, advising, and supporting—progressions that parallel in many ways the phases and support provided through collaborative apprenticeships.

Peer coaching and study groups have also proven effective in promoting classroom technology integration (Beaver, 2001; Doersch, 2002; Poplin, 2003). Coaching enables teacher-leaders to orchestrate the growth of their peers through encouragement and feedback as they co-design and -develop instructional strategies. Hence, in technology integration efforts, collaborating teachers share responsibility for each other's performance, reciprocally sharing strategies and providing continual feedback.

Community-wide participation and shared responsibility among teachers supports and sustains mutual engagement (Seels, Campbell, & Talsma, 2003). A teacher may have a central role in orchestrating peer learning with a particular tool, but a peripheral role in incorporating it instructionally. Participating in multiple professional learning venues not only diversifies learning experiences, but also expands teachers' shared repertoire of common tools and language. Hence, a *combination* of mentoring and apprenticing across teachers enables ongoing opportunities for various forms of participation and joint enterprise in the community's shared vision. In contrast to the diffusion of expertise in many professional development initiatives, partnerships are situated in the context of the teaching community and school day (Swan et al., 2000). Peer-teachers contribute in both peripheral and legitimate forms to the design and development of learning activities prior to mastery as they gain expertise through their participation (Lave & Wenger, 1990). Modeling is critical to facilitate such an effort. Effective leaders not only manage and provide support, but also learn and value the input from other teachers (Huffman, 2000).

Developing Strong Leadership in Technology Integration

To implement collaborative apprenticeships effectively, strong leadership and collaborative sharing of classroom experiences are needed from effective teachers; to integrate technology effectively within curricular practices, administrators must codevelop shared visions and goals with teachers (Whitfield & Latimer, 2003). Committees comprising visionaries, supporters, and skeptics need to shape the standards and expectations for technology use and mentorship and professional learning programs, as well as allocating resources to support the school's goals. The technology coordinator is especially important in advancing curricular and professional development initiatives (Glazer & Page, in press; Whitfield & Latimer, 2003). A technology coordinator can scaffold teacher learning and implementation, as well as offer timely advice when mentors are unavailable. Reciprocal interactions with a technology coordinator serve to catalyze professional growth across the community. In schools where technology coordinators have little experience in classroom technology integration (Seels et al., 2003), they may profit from the experience of the teaching community.

Supporting Teacher Empowerment

Collaborative apprenticeships provides a forum where all members in the school community can draw expertise from one another. In order for each member to contribute, they need to be empowered to do so. Browne and Ritchie (1991) described *teacher empowerment* as peer-teachers gaining ownership in their development. Empowerment enables teachers to explore how technology tools can be used in different capacities to serve different instructional purposes. Further, empowerment implies intellectual ownership and evolution of knowledge in the learning community, requiring a new set of

teachers to serve as mentors of their peers each year. Providing opportunities for teachers to assume leadership roles can help teachers progress from peripheral participants as novice teachers to central participants as teacher-leaders in a community of practice (Howe & Stubbs, 2003).

CONCLUSION

Collaborative apprenticeships provide an authentic, situated, and theoretically grounded alternative to traditional technology integration workshops or pull-out professional development programs. Successful implementation of the model in a K–5 school setting, however, requires several implementati on criteria: (a) shared time; (b) teacher commitment; (c) teacher experience; (d) structure; and (e) teacher learning and development (Glazer & Page, in press). Shared time (e.g., a common planning time) provides opportunities for teachers to share ideas and work collaboratively. When committed, teachers willingly allocate time to develop their ideas in order for their peers to benefit from each other's experience and repertoire. Mentoring requires that a diversity of experience be available among teachers within the community to foster collaboration and learning. An organized, goal-oriented meeting agenda can help motivate teacher participation and engagement, because teachers need assurance that meetings are personally and professional meaningful to them.

Collaborative apprenticeships embody strategic approaches to initiate and sustain technology integration efforts among teachers at different levels of expertise. The model both engenders and depends on participation and collaboration across the community, promoting internal leadership among practitioners so that all teachers become invested in the shared goals of the community. Teachers likely need incentives, such as in-service or recertification credit, which go beyond the intrinsic rewards of improved instruction, to participate in collaborative apprenticeship because the increased effort requires time and cognitive energy. Implementation of collaborative apprenticeship approaches may help to overcome many practical, everyday obstacles, such as lack of time, lack of on-site support, and lack of authentic learning experience, thereby promoting learning as a natural component and expectation of the teaching community. Although the success, durability, and sustainability of the approach require administrative support and leadership as well as teacher investment and involvement, these requirements may prove modest by comparison given the limited success of existing approaches and the stakes involved in promoting effective technology integration. □

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