USING COLLABORATIVE APPRENTICESHIP TO EXAMINE

FACTORS AND RECIPROCAL INTERACTIONS THAT AFFECT

A COMMUNITY OF TEACHERS' INTEGRATION OF TECHNOLOGY

by

EVAN MICHAEL GLAZER

(Under the Direction of Michael J. Hannafin)

This study examined the factors and interactions that support teachers' technology integration efforts using a Collaborative Apprenticeship framework. Teachers with experienced technology use served as mentors of technology applications aimed at improving instruction. Technology was gradually infused through the curriculum as teachers learned to design technology-rich lessons from their technology-savvy peers through modeling, collaboration, and coaching. Results suggest that shared planning time, shared curriculum, connection to an individual, expertise, physical proximity, and comfort level influenced interactions across the community of practice. Posing and responding to task-based questions, giving and seeking advice, and sharing ideas comprised more than 70 percent of the observed interactions between teachers. However, the nature of interactions changed as teachers gradually assumed more responsibility in designing technology-enhanced lessons. Teacher-leaders initially modeled exemplar applications of technology-enhanced lessons and gave advice on using them in classrooms; then, the community of teachers brainstormed new ideas in collaborative efforts, and teacher-leaders motivated peers to develop original lessons independently.

Implications for collaborative apprenticeships and learning in professional environments are provided.

This study also examined the factors and interactions that support teachers' mentoring and development as teacher-leaders supported peer efforts to integrate technology. Results indicate that teachers who were more successful in designing technology-enhanced lessons tended to interact differently from their peers. Rapidly developing teachers assumed more ownership in their learning and consequently interacted more frequently to obtain support and advance their development. Further, when their primary motivation was to develop strategies to improve student learning, successful teachers overcame learning obstacles. Peer mentoring techniques also influenced the interactions and quality of teacher growth in the community. In general, mentors resisted interactions perceived as potentially jeopardizing collegial and interpersonal relationships, even when peers did not demonstrate growth in their learning.

INDEX WORDS: professional development, collegiality, group dynamics, educational environment

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EVAN MICHAEL GLAZER

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by

EVAN MICHAEL GLAZER

Major Professor: Michael J. Hannafin

Committee: S. Frances Hensley
Janette R. Hill
Thomas C. Reeves
James W. Wilson

Electronic Version Approved:

Maureen Grasso
Dean of the Graduate School
The University of Georgia
August 2003

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PROLOGUE

The purpose of this prologue is to provide a rationale for my research agenda examining the role of reciprocal interactions and to introduce the structure of this dissertation. My professional background, subjectivities, and prior research have influenced the nature of this work.

Professional Background

I taught high school mathematics for five years in suburban Chicago and valued the collegiality, professional opportunities, and flexibility to creatively orchestrate learning. The school is predominantly white, middle/upper class, with about a 35 percent mix of students from various minority backgrounds. Of the 2400 students, at least 90 percent generally pursue some form of advanced education. Teachers have wide access to physical and human resources, primarily due to the leadership of an outstanding department head. Teachers in the mathematics department are situated in a shared, open environment without dividers where they have opportunities to interact informally, as well as meet with students.

The department was mutually engaged in professional development aimed at improving learning with shared goals. There was a "we" attitude instead of an "I" attitude among teachers and students. Teachers did not declare intellectual ownership of their work. Instead, they collaborated, shared, and welcomed new instructional ideas, resources, and strategies. Teachers in the community created weekend workshops, seminars, and study groups to learn new innovations and develop instructional resources.

It seemed that everyone wanted students to achieve; giving time and resources was a means to "share the wealth." In essence, teachers continually helped each other in order to support the development of an eclectic and dynamic learning community.

My teaching experience instilled a belief that learning and development improve in social environments when participants have opportunities to continually engage, challenge, and push each other to grow and achieve professionally. The school's administrative leadership gave teachers autonomy and empowerment to plan curriculum, try new ideas, and explore different resources. For these reasons, I have become interested in Lave and Wenger's work on situated learning (1990) and Wenger's communities of practice (1998): sharing knowledge within a community with a belief that social norms influence negotiation among its participants. In addition, apprenticeships are valued throughout the community, where individuals are sometimes experts and sometimes learners depending on the learning context. In my opinion, legitimate peripheral participation among newer community members is crucial for the evolution of the community because *all* participants influence the development and advances of shared goals.

Through teaching experiences and interaction with colleagues, I have developed strong affinity for reciprocal learning, where community members assume responsibility and share interest in each other's learning and development. For instance, if a new teacher were overwhelmed by three new classes, another teacher might offer support by providing instructional resources and acting as a mentor. Active modeling of these behaviors among leaders in the department instills thoughtful interactions and a desire to continually grow and support community members.

As I developed professionally, technology integration, especially related to problem-based learning using Internet sources, became increasingly important. I felt comfortable with computers and was excited about the opportunities to enhance learning. My involvement with technology in mathematics was a golden opportunity to enhance my computer skills, create new ideas that teachers could use in their classrooms, and develop a vision for restructuring school mathematics in technology-assisted classrooms.

Over time, my understanding of technology applications stalled because learning experiences became overwhelmingly self-taught. The teaching community had many strengths, including ongoing collaboration through interactions, yet was bounded by the knowledge, skills, and experiences of its participants. My technology use superceded most of my peers, thus limiting my learning potential to personal exploration and ideas gained from professional conferences. Although these experiences were useful, I wanted to accelerate my growth by transferring to a learning environment focusing on integrating technology and studying advanced applications. Hence, I chose to pursue graduate study in the field of instructional technology instead of mathematics education because it provided more opportunities to interact with people from other backgrounds and specializations. A diverse community enhances my perceptions about learning because there is a wider range of opinions, ideas, and historical perspectives to discuss in such an environment. Furthermore, experiences outside of my primary domain enable the strengthening and broadening of my mental models of teaching and learning with technology.

Subjectivity

My research questions and methodologies are influenced by several biases. *I consider myself a social constructivist who values development, reciprocity, learning communities, and service.* All of these elements co-exist and are interrelated to influence my perceptions about learning and society. Much of this perspective was shaped by my teaching experiences, but it has become clearer during my experiences at the University of Georgia.

Although I greatly value the opportunities to reflect and pursue intellectual interests in higher education, my current professional environment is quite different from my prior teaching experiences. For example, intellectual ownership of research and writing is a component of the academy I perceive to prevail in tenure track positions. This representation conflicts with my value of promoting shared knowledge that is jointly constructed across members of a community. Thus, to accommodate these philosophical differences, I pursue a research agenda focused on mutual collaboration and development in school settings. Ideally, I would like to be part of systemic efforts where teachers formulate their professional needs, generate ideas, and work in partnership to enact their vision. In essence, I view my collaboration with teachers as being analogous to teachers' collaboration with their students. We both strive to orchestrate learning environments that address the individual and collective needs of the learners and support them in accomplishing their goals.

Another component of my subjectivity is promoting community goals over individual goals. Since I value the social and mutual development of cognition and practice, I de-emphasize individuality within social learning environments. Each individual brings and takes their own perspective to and from a situation, but I believe that greater meaning develops through the goals of and interactions within the community. For example, I feel uncomfortable when people are more concerned with what they will gain from an experience than what they contribute to it. Without commitment to the collective goals of the community, learning becomes an individualized process that benefits only the individual and others interested in that specific area of expertise. Sadly, this disposition can contribute to isolation, with individuals focusing on self-interest and survival and not supporting each other's needs, growth, and development. Conversely, dedication to community goals focuses on improvement of the group, which often provides strength to each individual.

One last issue that shapes my professional pursuits is the desire for my research to benefit teachers. It is important that my research provides teachers opportunities to learn, while at the same time allowing me to examine the theoretical perspective of professional learning environments. I want teachers to gain as much from participating in the research experience as I benefit from their contributions. I use presentations at teacher conferences, publications in teacher journals and books, and design and development work for Web-based learning enterprises to provide K-12 teachers with experiences to enhance their instruction. These contributions are critical to demonstrating the synergy among research, theory, and practice.

Research Agenda

The aforementioned professional experiences and perspectives have shaped my research trajectory to incorporate situated professional development, technology integration, and professional learning communities. I have developed theoretical frameworks that embody social interactions as a mechanism for learning, such as those in mentoring relationships. I have incorporated situated learning in school environments as a research context in an effort to provide teachers with practical experiences to enhance their development. Further, I have created a professional development model to explore ongoing professional learning across a community of teachers.

In the spring of 2000, I conducted a pilot study focused on the professional development of a teacher using cognitive apprenticeship techniques (Collins, Brown, & Newman, 1991). In this study, I served as a mentor scaffolding the teacher as she learned to design and develop technology-enhanced classroom learning activities. The appended paper, *From a caterpillar to a butterfly: The growth of a teacher in developing technology-enhanced mathematical investigations*, describes the study, and was submitted for publication to *Technology and Teacher Education* in December 2002. Although an individual teacher became successful and independent in the pilot study, I became interested in whether similar techniques could be effective across a community of teachers supporting each other's needs. Following the pilot test, I explored the feasibility of cognitive apprenticeship for a larger teaching community with less researcher intervention. After all, the success of the pilot study teacher could have resulted from my mentoring, regardless of the cognitive apprenticeship techniques. After reflecting on the implications of the pilot study, a framework was developed to address how a community of teachers collaboratively learns to integrate technology in their teaching. In this setting, experienced teachers and technology coordinators serve as mentors to their peers. Based on a literature review of reciprocal learning arrangements, I devised a model called *Collaborative Apprenticeship* for integrating technology in a community of teachers. The model extends Collins' cognitive apprenticeship to account for characteristics of a community of practice (Wenger, 1998), namely joint enterprise, shared repertoire, and mutual engagement. Instead of focusing on the characteristics that affect individual development, the following research examined factors that affect the professional growth of a community – the interactions between individuals and the cultural, environmental, personality, beliefs, affective, and cognitive factors that influence those interactions.

My commitment to K-12 education should promote the synergy among research, theory, and practice—to develop a research agenda in the context of schools, and apply research findings to inform and support practitioners. Thus, a symbiotic relationship with schools will enable opportunities to propel my research, writing, and development forward for the benefit of broader research and practitioner communities.

Significance of Research

I intend to advance new perspectives about professional development and communities of teachers through this research. Previous research on collegial interactions (Sandholtz, Ringstaff, & Dwyer, 1994) and mentoring relationships (MacArthur et al., 1995) focused on the teachers' adoption of an innovation and changes in instructional practices, but not the importance and value of the teachers as a learning community. Technology integration efforts need to address both individual and, more importantly, community growth. Teaching communities that demonstrate joint enterprise, shared repertoire, and mutual engagement (Wenger, 1998) may demonstrate how professional development can be supported and sustained within the everyday school context.

My dissertation research emphasizes the value of reciprocal interactions as a means to accomplish shared goals. This focus extends professional development models and practices because it transcends the basic acquisition of individual content, skills, and strategies. It emphasizes support for ongoing learning and relationships to strengthen the motivation and confidence to attain goals in a collaborative effort. Revealing critical interactions to support technology integration can guide teacher educators, administrators, and practitioners in their efforts to optimize situated professional development.

Dissertation Format

I plan to pursue a career path of writing, research, and teaching related to technology in teacher education. Expectations of such a career path involve writing to scholarly audiences, as well as communicating ideas to practitioners to bridge research and theory with practice. Hence, my dissertation format serves this purpose and provides an opportunity to immediately publish my work and pursue my research agenda at my next institution. The following six papers in this dissertation encapsulate the research and professional development I have orchestrated from August 2002 to February 2003, as well as next steps in my professional agenda:

- *The Collaborative Apprenticeship Model: Situated Professional Development Within School Settings* is a theoretical framework that outlines the factors and interactions to support situated professional learning. The paper also provides a rationale for collaborative apprenticeship as a model cultivating the various factors and interactions. The intended journal for this article is the *Journal of Teaching and Teacher Education*.

- *Promoting Technology Integration Through Collaborative Apprenticeships* explains how collaborative apprenticeship can be used to support technology integration that reinforces onsite, ongoing, and 'just in time' support. Operational procedures of collaborative apprenticeship and roles of teacher-leader and peer-teacher are discussed. The intended journal for this article is *Educational Technology Research and Development* or the *Journal of Teacher Education and Contemporary Issues in Technology*.
- *Using Collaborative Apprenticeship to Examine Factors and Reciprocal Interactions That Affect a Community of Teachers' Integration of Technology* describes questions, methods, and findings of collaborative apprenticeship research used in a community of 5th-grade teachers. Specifically, the influence of interactions to support or prevent technology integration, and the influence of factors to support or prevent interactions are examined. The intended journal for this article is the *Journal of Research on Technology in Education*.
- *Factors and Interactions That Affect Professional Growth When Integrating Technology* describes questions, methods, and findings of collaborative apprenticeship research used in a community of 5th-grade teachers. Specifically, the factors and interactions that affect the professional growth of teachers, as well as the teacher-leaders' influence on professional growth of the community, are explored. The intended audience for this article is *Technology and Teacher Education*.

- *Transforming Technology Training: A Technology Coordinator's Role in the Planning Process* is aimed at supporting technology coordinators in their technology integration efforts. The piece reflects on how to promote collaborative apprenticeship in a school setting and describes the learning experiences of the technology coordinator. The intended audience for this article is *Learning & Leading With Technology*.
- *Challenges and Strategies to Peer Mentoring* is an examination and reflection on how mentors play a critical role in the development of their peers. This focus developed as an unanticipated finding from the research process. The intended audience for this article is *Educational Leadership* or the *Phi Delta Kappan*.

The series of articles are intended to not only capture the research experience, but also to communicate the issues most useful to different audiences. Each article discusses technology integration issues from a different perspective in an effort to promote relevancy to multiple professional populations – those that examine research, theory, and practice surrounding technology and teacher education.

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CHAPTER 1

THE COLLABORATIVE APPRENTICESHIP MODEL:

SITUATED PROFESSIONAL DEVELOPMENT WITHIN SCHOOL SETTINGS[1]

[1] Glazer, E. M., & Hannafin, M. J. Submitted to *Journal of Teaching and Teacher Education*, 6/5/03.

Abstract

Professional learning often occurs outside of the context of the school day, and is often ineffective because teachers fail to adequately transfer knowledge and skills to their instructional practices. Teachers need ongoing learning experiences situated in the context of their teaching to concretize new ideas or abstract principles. Professional learning is a social enterprise where peers rely on the expertise and support of one another to adopt innovative practices. Reciprocal interactions in a community of practice, where teachers take responsibility for each other's learning and development, may provide an effective means of supporting situated professional learning. In an effort to characterize the nature of reciprocal interactions during learning, various influences related to affect, beliefs, environment, culture, cognition, and personality are examined. We propose a Collaborative Apprenticeship model featuring reciprocal interactions as an approach to promote professional development, encouraging peer-teachers to serve as modelers and coaches of strategies and ideas aimed at improving instruction.

The Collaborative Apprenticeship Model:

Situated Professional Development Within School Settings

Professional development affects teacher growth, variations in instructional techniques, and improvements in student learning (Joyce & Showers, 1995). Teachers learn new ideas and strategies through a variety of venues, ranging from structured classes during the summer to informal discussions during lunch. Pull-out workshops are commonly employed to give teachers intensive and focused learning experiences. However, there is limited evidence that isolated professional learning experiences of this nature improve classroom practices (Fullan & Stiegelbauer, 1991; Loucks-Horsley, Hewson, Love, & Stiles, 1998). Workshops are discrete experiences that fail to provide ongoing support and continual feedback to attain long-term, systemic improvements (Mouza, 2002). Skills and strategies simply do not transfer well when they are not learned in situated contexts (Brown, Collins, & Newman, 1989). Further, workshops enhance an individual teacher's repertoire rather than impact a professional community, limiting collective understanding and impact (McCotter, 2001). Researchers and practitioners need alternative and feasible methods that support a teaching community's development and implementation of new practices, and sustain their continual learning and opportunities for professional growth.

Teacher support is widely considered most effective when it is situated in everyday experiences, such as in classroom settings (Fullan & Stiegelbauer, 1991). Ideally, teachers receive support as needed as they implement their instructional practices. However, pragmatic constraints, such as limited resources and school budgets, affect the amount and quality of ongoing support provided by instructional and technical specialists. Ongoing support, where provided, is often isolated; an individual teacher receives help to address a specific crisis. The approach amounts to immediate, short-term triage for a systemic, long-term dilemma. In addition, the interactions typically are not reciprocal; teachers passively wait for resolution to a problem rather than proactively engaging the obstacle and participating in its remedy. Consequently, the support fails to encourage distribution of knowledge and strategies; teachers become unduly reliant on “others” to address instructional problems and fail to develop, refine, and share strategies as a community.

Ideally, teachers become empowered by teaching, learning from, and supporting one another *during* their school day (Hall & Davis, 1995). Learning experiences are enhanced when they are situated in the context in which they will be needed (Brown, Collins, & Duguid, 1989). Teachers can engage in these experiences through coaching and mentoring (Gottesman, 2000; Joyce & Weil, 1996; Kruse & Louis, 1993), where they model instructional strategies, obtain feedback, offer suggestions in an effort to improve instruction, and derive a shared understanding within the community (Browne & Ritchie, 1991). The mentoring process involves developing teaching expertise, fostering relationships between colleagues, and responding to learning needs (Hertzog, 2002). Support becomes a mutual responsibility, where individuals interact reciprocally with the intent to develop a common understanding that is distributed throughout the community. For example, protégés in mutual mentoring relationships challenge ideas of and formulate new ideas with their mentors (Beyene, Marjorie, & Sanchez, 2002). Thus, to progress in their implementation of new ideas and strategies, teachers need to employ methods that support reciprocity in their collegial environment—opportunities to interact with and learn from one another.

This paper presents a model for improving professional learning practices by cultivating teaching communities situated in school environments. We begin by briefly describing the context of teaching to expose pragmatic constraints, and benefits, to situated professional learning. We then define reciprocal interactions, a key factor to enhance professional learning, and explain how the concept has been used to support teacher learning and performance. Next, we then introduce factors that influence reciprocal interactions to cultivate a dynamic interactive environment. Finally, we propose Collaborative Apprenticeship, an approach designed to support and sustain professional learning through stimulation of reciprocal interactions and related factors.

The Challenges of Professional Development and Classroom Teaching

Teachers have an unusual number of roles and responsibilities, many of which are unknown or misunderstood among the general public. Teachers plan for their classes, help students prior to and after class, develop tests, assess students' learning, complete a myriad of reports, meet with parents, and seek ways to improve their instruction. Many participate in extracurricular activities before and/or after the school day. Limited opportunities, as well as time, are available for exploring, self-teaching, and reflecting. Paradoxically, teachers who improve student learning through innovative and alternative methods are gratified by their commitment to professional learning beyond their other responsibilities (Ritchie & Rigano, 2002). Professional growth across a school, however, is limited when learning opportunities are only pursued by intrinsically motivated teachers willing to enroll in workshops, attend conferences, and explore resources.

Research (c.f., Lave & Wenger, 1990) has indicated that professional growth can be pervasive when learning is viewed as a collective enterprise. Through this approach, teachers do not pursue opportunities to learn for their individual benefit, but instead utilize the instructional resources and skills of their peers to support mutual growth and attainment of community goals. In essence, rather than rely on individual motivation, professional learning can be viewed as an integral and continual component in a community whose teachers are vested in promoting each other's development.

Overcoming peer isolation is a challenge to situated professional learning (Little, 1982). Teachers will not likely improve their instructional practices, or their colleagues', if they believe that teaching is a private activity without peer influence and support. Further, teachers experience difficulty developing community goals and implementing strategies when not given shared time and space to collectively engage in dialogue (Gallagher & Ford, 2002). The absence of collegial interaction hinders community-wide professional learning. Teachers who seek to develop effective and interesting approaches need ongoing, sustainable support to ensure their value (Honey & Henriquez, 1993; OTA, 1995; Schrum, 1999). They need to interact regularly with their peers in order share successful experiences, and learn from each other's mistakes (Boyd, 1992). Teachers need a supportive, collegial environment in which to learn by sharing ideas with one another, asking questions, and obtaining support quickly and efficiently. Hence, establishing such an environment is critical to support reciprocal learning arrangements and collective thinking.

The Importance of Reciprocity

Reciprocal interactions, for the purpose of this paper, are defined as interactions demonstrating and influencing a mutual relationship supporting teacher learning and development. The interactions can be expressed through various forms of communication, such as in writing, verbal and non-verbal gestures, and physical movements. Reciprocal interactions can occur between individuals, such as colleagues troubleshooting an instructional problem, or among a community, such as a group of teachers collaboratively designing a curriculum.

Reciprocity has been described as a mutual relationship that supports interaction, assistance, and benefit. In their study of the relationship between adult learners and their teachers, Chene and Sigouin (1997) described reciprocity as "the mutuality of exchange between the learner and the teacher; reciprocity means that the learner and the teacher are learning from each other, as well as giving affective responses to each other's demands" (p. 253-254). In nursing education, reciprocal learning has been used to describe collaborative peer teaching in clinical environments:

> A way to introduce students to real-life situations in independent practice, a vehicle for personal and professional growth and development, for increasing problem-solving skills and trust, for enhanced accountability, and for providing opportunities to practice collaborative skills in the professional work situation (Goldenberg & Iwasiw, 1992, p. 27).

Russell and Cohen (1997) described reciprocity as tantamount to having a reflective colleague who, "holds similar beliefs, recognizes signs of excellent practice and gives accolades, asks for clarification of beliefs, provides alternatives to consider, and offers future and global projections that transcend the immediacy of the specific problems at hand" (p. 144). In an ideal state, reciprocal relationships are:

> Those in which each participant influences and acknowledges the influence of the other by performing parallel, and symmetrical, actions…. each participant displays similar behaviors, either alternately or simultaneously, thus sharing the power and feels free to behave in the same way as the other differently (Hall & Davis, 1995, p. 38).

However, the mutual exchange in reciprocal environments is not necessarily symmetrical or equivalent due to varying expectations and expertise in a learning community. Therefore a reciprocal arrangement is not necessarily based on an exchange of information or affection, but on the willingness to support the cognitive and affective needs of learning cohorts (Chene & Sigouin, 1997).

Table 1.1 illustrates several reciprocal interactions applied in the learning and professional communities literature. *Story telling* is a means of sharing and constructing knowledge and strategies. In a study on the learning and development of repairpersons, Orr (1990) noted, "this construction of their identity as technicians occurs both in doing the work and in their stories, and their stories of themselves fixing machines show their world in what they consider the appropriate perspective" (p. 187). The workers reported the need to relate stories in order to obtain a better interpretation of their training and formal written rules and expectations. Technical manuals were insufficient to provide information and strategies for realistic problem solving. Instead, personal experiences of similar stories were shared to develop a deeper and more relevant meaning of information from the manuals. In teacher education, Rust (1999) described the importance of story-telling as new teachers faced challenges in urban environments. The stories provided an authentic context to explain the necessity of acquiring various teaching strategies. In both cases, as stories were shared, the corporate knowledge and community development co-evolved with the experiences and perspectives of individual members.

Insert Table 1.1 Here

In a study of practicing teachers, Waugh, Levin, and Smith (1994) found a "*backscratching*" approach helped to engage people in their network projects. As community members developed ideas and called for participation, some mentioned they would join the project if the favor were reciprocated by the joining of another person's project. Consequently, both participants were able to engage in two different projects, each taking the lead on one—a strategy central to the Learning Circles of AT&T’s Learning Network. Lee (1999) described a similar experience with a study abroad, distance-learning program where the countries "barter" instructional content and cross-cultural exposure. These types of reciprocal arrangements typify extrinsically motivated conditions for participation.

Teachers sometimes interact to *discuss and resolve conflict*, or uncertainty, in their teaching. For example, Zahorik (1987) reported that teachers interacted when they became “stuck” with an instructional or discipline issues. The interaction provided opportunities to exchange ideas and create possible solutions. Teachers also interact to explore various instructional strategies to teach particular concepts, seeking opinions from colleagues before making a decision. Palmer (1993) encouraged faculty members to identify and discuss “critical moments” in their instructional practices throughout a semester-long course as a means to address difficult issues. This type of conversation provided an opportunity for an open dialogue where individuals felt they could contribute experiences and create meaning both individually and socially.

Many teachers find *brainstorming* a useful interaction in order to gain insight into creating a new lesson, an instructional strategy they are using, or generating possible solutions to classroom challenges. Korineck and McLaughlin (1996) emphasized brainstorming as a critical process in understanding and working through classroom problems using an Intervention Assistance Teaming (IAT) Model. The highly structured collaborative framework encouraged peers to continuously generate ideas and suspend judgment through the brainstorming sessions. Hasbrouck and Christen (1997) incorporated brainstorming as a component within peer coaching to help teachers reflect on classroom observations. The brainstorming sessions enabled both teachers to offer a variety of approaches to addressing an instructional situation. Brainstorming has also been helpful in professional development workshops because it can provide the teaching community a variety of perceptions on teaching particular concepts (Pieronek, 2001).

Modeling is also used to promote reciprocal actions among colleagues. Kohler, Ezell, and Paluselli (1999) used peer coaching to model strategies that increase interaction among students. Teachers observed each other's instructional technique in classroom environments to record notes to provide better feedback. Modeling provided peers both an indication of how to teach a specific method and an opportunity to help a peer reformulate ideas and implement strategies. Chene and Sigouin (1997) found adult learners prefer their instructor or mentor to take control of the learning environment by modeling how to access knowledge, communicate information, and lead the direction of instruction. Such actions helped to reify teacher's competence and commitment towards making learning meaningful and interesting.

Teachers also *share ideas* with one another based on their teaching and learning experiences. Zahorik (1987) reported that teachers shared ideas with colleagues soon after they learned a new practice and tried it in their own classroom. Hence, this form of interaction differs from discussing and resolving conflict because teachers provided ideas without being prompted. In addition, sharing can incorporate the interchange of instructional materials (Clement & Vandenberghe, 2000), as teachers support one another in creating learning activities for their classrooms. In this process, teachers evaluate materials, discuss their classroom experiences, and make decisions about future use.

Hall and Davis (1995) described teachers as peer *motivators* that encourage and reinforce improvement and disposition. Motivators promote positive attitudes and build confidence by supporting, encouraging, and remaining active throughout a learning process, such as during student teaching. Story telling, pats on the back, and pep talks are common support actions used by motivators to sustain interest in new teaching activities. Motivation is commonly perceived as a cooperating teacher's responsibility, but student teachers exemplified this behavior when both student and supervising teachers were viewed as competent and collaborative, treating each other as equal participants in the instruction and learning process.

Giving and seeking advice is used among peers who seek knowledge and strategies from their counterparts. According to Moore-Johnson (1990), such interactions are important in a professional community because they help to address teachers' instructional and organizational needs. Hertzog's (2002) study on novice teachers indicated that new teachers seek advice from both novice and experienced peers after a problem has occurred in an effort to resolve it quickly. Novices tended to address problems with each other first, then seek mentors for advice when they could not resolve issues on their own. The advice shared between teachers related to different aspects of the job, such as classroom management, curricular pacing, at risk students, and interpersonal relationships. Among teachers with a common professional interest, Selwyn (2000) examined the type of advice requested and shared electronically among special needs coordinators. In this environment, teachers posed questions to the group about policy issues, resources, professional development and problem situations at their schools. However, the researchers found the advice was hampered since only a small percentage of the members regularly participated in the discussion forum.

Teachers also interact by *posing and responding to task-based questions* involving the transfer of knowledge and skills among members of a community. For example, Zahorik (1987) reported that teachers most frequently sought help in locating instructional materials in their schools. These interactions are reciprocal when teachers respond with intent to contribute to their peers' development, instead of one individual resolving another teacher's problems. In addition to locating resources, teachers may seek technical assistance to use various tools, such as computers and video equipment. Finally, teachers may interact to obtain information about school policies in order to carry out a task, such as those related to discipline, grading, and paperwork.

Research on collegial interaction highlights a variety of methods for supporting learning. The studies are often situated in learning communities, where interactions serve as a mechanism to support the growth of a peer and to distribute knowledge and strategies across a community. By exploring the theoretical underpinnings of a community of practice, we can gain insight into how interactions support ongoing professional development.

Reciprocity and Community of Practice:

Teaching, Teachers, and Reciprocal Interactions

Reciprocal interactions represent one type of mutual engagement in a community of practice (Wenger, 1998). Mutual engagement reflects how participation and membership in a community influence both actions and social negotiation of meaning. In a community of teachers, mutual engagement suggests teachers have opportunities to contribute and react to instructional, policy, curricular, and development decisions influencing their professional environment. Mutual engagement, however, is not independent from shared repertoire and joint enterprise. Shared repertoire includes the common actions, language, and experiences of participants. In teaching communities, shared repertoire encompasses the practices engaged by every member of the community, such as teaching, learning, and curriculum. Joint enterprise, in turn, refers to the shared goals of a community. Individual members of the broader teaching community focus on attaining common community goals, such as a core curriculum and instructional methods.

Systemically, the three components support and propel each other. For example, when a teaching community has joint enterprise in creating a curriculum, the process necessarily includes interaction and negotiation about content and instructional activities. This negotiation occurs mutually, whereby the creation of instructional materials and participant learning follows from the sharing of experiences and responsibilities. Reciprocal interactions occur via communication among two or more people. In this process, human behavior is stimulated by the interdependence of cognitive, behavioral, and environmental influences (Bandura, 1986). The interaction features a *helper* who responds to inquiries or stimuli from a *learner*. The helper is presumed to be more knowledgeable than the learner about the topic, and can presumably extend the learner's related knowledge and thinking. For example, a teacher who has used a given method in her classroom can likely help a teacher who has not. According to Vygotsky (1978), individuals reach a barrier to further understanding about a particular concept or skill known as the zone of proximal development. In order to extend the understanding beyond this zone, a more or differently knowledgeable source assists the learner by means of a social interaction until competency is obtained.

However, since cognition is often distributed among participants in learning environments, the knowledgeable source varies according to learning context (Greeno, 1997; Pea, 1993). Each individual possesses specialized knowledge and unique skills, so individuals in the learning community alternately assume the roles of helper and learner. In a teaching community, one teacher may have expertise using technology, while another has a deep understanding of hands-on teaching and learning. Each, alternately, helps and learns as their unique strengths or weaknesses dictate.

Knowledge, skills, and strategies become socially negotiated among members in the community through legitimate peripheral participation (Lave & Wenger, 1990) and sharing stories (Orr, 1990). Hence, mutual engagement in a community (Wenger, 1998) fosters reciprocal interactions so that newcomers are continually supported and mentored. As a result, they become capable of contributing to and developing the common goals of the community. In a teaching community, expert teachers pass on experiences and strategies to novices in order to familiarize new teachers with important principles and goals. During the transition into the teaching profession, experts support novices until they become full participants in the community, contributing to the issues that affect learning in their school and curriculum. As the new teachers gain experience, they contribute new ideas and strategies to improve the practices of their peer mentors.

Influences of Reciprocal Interactions

Reciprocal interactions are influenced by affect, beliefs, environment, culture, cognition, and personality. Discussion of these factors can provide insight into developing strategies that promote reciprocal interactions in a community of practice. While we isolate these factors for clarity in Table 1.2, their role in stimulating reciprocal interactions is interactive in practice.

Insert Table 1.2 Here

Affect

The affective domain, which comprises emotions and attitudes, plays a valuable role in an individual's decision to interact with a peer. For example, love, emotional support, and dependence promoting ongoing interaction were exemplified by an instructor and expected by students in a community of adult learners (Chene & Sigouin, 1997). Silva and Tom (2001) found that mentors who created a caring space for their interns to grow were able to foster risk taking, idea generating, and open discussions. Teachers sometimes commiserate by sharing frustration, anxiety, and discontent with school conditions, their students, or the teaching profession. Manouchehri (2001) described this as "getting something out of your system" (p. 93). Conversely, conflict among peers can inhibit interactions. Hawkey (1997) noted that mentoring can produce stressful situations that result in “unspoken agreements between mentor and mentee to collude in retreating from the challenges they each face” (p. 332). Kohler, Crilley, and Shearer (1997) noted that teachers who reported being acclimated to using technology in their classrooms were more satisfied when working with a peer coach on their instructional strategies; conversely, teachers did not interact with peers if they failed to recognize technology as benefiting their students' achievement.

Teachers' perceptions about peers, collectively and individually, also affect engagement. Glass and Walter (2000) noted a sense of belonging—being acknowledged, feeling validated, and verbalizing vulnerability—as characteristics associated with “connecting” among nursing students. Likewise, Grams, Kosowski, and Wilson (1997) described connecting among nurses as a form of bonding akin to the ties of family or a lifelong relationship. Bonding "encouraged a cohesiveness and a source of support and reinforcement that may not have otherwise been available" (p. 13).

Chene and Sigouin (1997) created a “friendly” climate by using positive words and gestures, acceptance of group members, equality of participation, and the like. Person-to-person relationships also stimulate reciprocal interactions. According to Manouchehri (2001), teachers reported being more comfortable talking about various issues with specific teachers due to their personal relationship. Hall and Davis (1995) recognized the need for cooperative and student teachers to “become friends” at times. Cooperative teachers recognized student teachers as “buddies,” with whom they could share experiences, obtain support, and discuss ideas at the end of a day. In addition to friendship, respect for a peer's knowledge and experience can influence collegiality and participation in group activities. An individual will likely be more inclined to participate and contribute to group goals knowing that ideas are respected and encouraged into the community activities (Dillon & Stines, 1996; Terehoff, 2002).

Beliefs

The nature and strength of a teacher's beliefs impact willingness and interest to interact. Teacher beliefs derive from experience as a learner as well as learning preferences. McCotter (2001) reported that teachers with similar beliefs tended to interact well together because they had common avenues to raise issues and validate their ideas. However, Arnn and Manigeri (1984) contend that it is more beneficial to foster collaboration among teachers with varied belief systems in order to promote diversity in understanding. In addition to their teaching practices, teachers have varied opinions about their learning and development, which in turn, may influence their interactions. Manouchehri (2001) found that teachers with different pedagogical styles tended to lack interest in learning new approaches, sometimes developing stronger feelings about their instructional preferences after observing different pedagogy. Reforming instructional practices can be further complicated when teachers hold different beliefs about curriculum (Rogers, 1999). Moreover, joint planning can be difficult for teachers of different repertoire, such as across grade levels, because they conceptualize instruction differently, even when they use the same terminology (Carr, 2002).

Beliefs about personal contribution and self-worth also influence collegial interactions. Some teachers assume a social obligation to contribute to their community's shared goals and tasks based on their own personal growth in the community. Since they developed as a consequence of others' contributions, many teachers reciprocate to the community by contributing their knowledge and skills (Silva & Tom, 2001). Self-efficacy, "people's judgments of their capabilities to organize and execute courses of action required to attain designated types of performances" (Bandura, 1986, p. 391), may affects one's role, responsibility, and willingness to engage and participate in reciprocal activities. Hall and Davis (1995) found reciprocity between student teachers and cooperating teachers was enhanced where cooperating teachers appeared confident and experienced. Generally, high self-efficacy tends to perpetuate success; conversely low self-efficacy engenders failure. However, where a community member has low self-efficacy, emotional support from other members may help to build esteem and desire for professional development (Chene & Sigouin, 1997).

Environment

Environmental factors affect an individual's desire to form and participate in mutual partnerships. For example, Brown and Duguid (1991) noted opportunities to interact regularly, during work and at lunch, resulted in improvements in learning and performance as individuals passed on stories to one another. By supporting proximal interactions, learning is a participation-based activity where experiences are shared and formalized through informal means. Rossman (1984) created intentional proximity by visiting students at their home and work, observing that her professional relationships improved as well. The physical presence of a peer makes possible opportunities to share time. Clement and Vandenberghe (2000) noted that teachers created opportunities to share stories and provide help by scheduling one hour a week to meet outside of class. Without making time for interactions, Zahorik (1987) found that teachers were often unable to resolve problems and issues during the school day. Moreover, when teachers have inadequate individual time to complete paperwork and administrative responsibilities, they are unlikely to interact with and learn from peers to address instructional issues (Hunter, 2001; Lohman, 2000).

Access also affects interactions among peers. When teachers realize their peers are routinely available to help, they are more likely to seek assistance to resolve problems efficiently, and understand their peers' growth through ongoing dialogue (Sandholtz & Wasserman, 2001). Experienced teachers can serve as a focal point of interactions as they share classroom stories with their peers (Sandholtz, Ringstaff, & Dwyer, 1994). Over-dependence on the resident expert, however, can limit interactions unless attempts are made, such as collaborative projects, to draw strengths from every teacher in the community (Sandholtz, Ringstaff, & Dwyer, 1994). Access to physical resources, such as computers, software, lesson plans, and resource manuals also affects interactions. Lohman (2000) found that lack of proximal resources interfered with teachers' development in that it became difficult to exchange knowledge with peers, experiment with new ideas, and gather and explore instructional resources. Nisan-Nelson (2001) described a teacher who presumably could not integrate technology due to continued frustration with scheduling lab time and failed collaboration with the school's media specialist. Thus, limited access to resources may, in turn, isolate teachers from relevant interaction resources.

<u>Culture</u>

Interest in teacher-leadership is pervasive throughout professional development literature as a means of promoting active involvement, collegiality, ownership in decisions, and professional community (c.f., Carr, 1997; Keedy, 1999; Palmer, 1993). In successful mentoring partnerships, mentors exhibit a greater sense of professionalism toward their peers in an effort to model positive adult interactions, idealism in the classroom, and effective teaching strategies (Davies, Brady, Rodger, & Wall, 1999). A shared curriculum also promotes advice-seeking and strategic planning, as many teachers collaborate to modify their curriculum to provide the best possible learning opportunities (Garet et al., 2001; Manouchehri, 2001). Conversely, teachers who do not value the existing curricular materials may choose not to interact with peers, especially those with different opinions.

The nature of efforts to promote collaboration also influences peer interaction. For example, mutual responsibility among peers, whereby peer dependence is critical for professional improvement, can influence reciprocal behaviors. Reciprocal peer coaching "provides a safe environment in which to learn and perfect new teaching behaviors, experiment with variations of strategies, teach students new skills and expectations inherent in new strategies, and thoughtfully examine the results" (Showers, 1985, p. 47).

Peer feedback also supports and sustains reciprocal interactions. Kohler et al. (1999) used peer-coaching techniques among teachers to learn and compare instructional strategies. Peer-teachers observed each other's classrooms, discussed and evaluated each other's activities following implementation, and reflected on how classroom experience related to instructional goals. Finally, Hall and Davis (1995) noted the student teaching experience involves shared tasks with a cooperating teacher when planning and grading, as well as implementing curriculum, instructional strategies, and discipline. Some student teachers were involved in school meetings that emphasized decisions as a "we" process, indicating mutual involvement and contribution to school policy.

<u>Cognition</u>

Reciprocal interactions may be triggered by the lack of knowledge and skills and lower-order thinking, causing individual to seek solutions through interactions. Manouchehri (2001) noted that one teacher in her study persisted in seeking collegial interaction because she was “unsure” about her teaching. The teacher sought information from a more experienced peer with a mathematics background due to her limited background in the content area. Conversely, a teacher learning new skills may be reluctant to interact until she believes that her contributions are meaningful to the learning environment. If the culture does not accept or encourage dialogue to resolve a lack of understanding, then interactions may not occur or may be isolated to few individuals (Hertzog, 2002).

Teachers might also engage in collegial discourse about ways to resolve issues using higher order reasoning, such as analysis, synthesis, or evaluation. For example, some teachers find it helpful to discuss thoughts and ideas with peers and consider alternatives before making decisions (Little, 1982; Clement & Vandenberghe, 2000). Reflection can stimulate reciprocal interactions. For example, McCotter (2001) encouraged teachers to be more “wide awake” about their experiences by retelling an experience, learning though social interaction, understanding the context of the experience, and understanding emotions and ideology. Reflection can also provide a catalyst for discussing and resolving conflict through modeling and peer feedback. To illustrate, Manouchehri’s (2001) teachers discussed reactions to instructional approaches after observing each other's classrooms. Pairs of teachers used reflective activity to compare their experiences and observations in an effort to stimulate future directions in their teaching. However, peers with conflicting beliefs or limited assertiveness failed to benefit from the reflective experience.

In social settings, learning involves how individuals think and respond to their peers' understanding, such as developing a common understanding across peers engaged in the same task. When teachers present the same lesson, they might discuss prerequisite activities, instructional strategies, assessment instruments, and other challenges in an effort to share perspective on the lesson (Talbert & McLaughlin, 1993). Shared understanding is important in promoting a professional community, and central to prolonged teacher commitment (Hausman & Goldring, 2001). When teachers need to accomplish a task in the near future, or need 'just in time' support, they may interact with a peers to overcome the obstacle (Zahorik, 1987). Conversely, teachers may abandon planned interactions if they need to address a seemingly more urgent problem.

Awareness of how to be a social learner, where the "individual learner’s learning system extends its capacity to deal with the critical conditions of learning by acquiring new ways to capitalize upon the social surround" (Salomon and Perkins, 1998, p. 5), is also important. If unaccustomed to social learning, individuals may not understand the benefits of reciprocal interactions. Participants need to develop a sense of what social learning represents, both personally and to the community, and to become familiar with negotiated expectations and understandings. Arnn and Manigeri (1994) described this as “having a keen awareness of their impact on others,” (p. 32) including knowing how others view a teacher’s role and responsiveness in a professional community. With awareness across the community, learning becomes a "reciprocal spiral relationship"

(Salomon & Perkins, p. 16) where individual action influences social behavior, and vice versa, in an iterative fashion.

Personality

Personality traits can either foster or hamper interactions. A proactive personality is assertiveness, evident where teachers make significant efforts, regardless of location or time, to interact with peers, discuss ideas, and obtain advice (Zahorik, 1987). When not proactive, some teachers become isolated and limited to resources conveniently available (Lohman, 2000). Motivated teachers strive continually to interact with peers in order to improve their teaching (Manouchehri, 2001). More importantly, the desire for professional growth and collaboration focuses on thinking and learning in the classrooms (Franke, Carpenter, Levi, & Fennema, 2001). Teachers who both take ownership of their professional growth and support the development of their peers contribute uniquely to the professional community (Grossman, Wineburg, & Woolworth, 2001). Hunter (2001) found that teacher dedication to achieve a common goal was a principal factor in a teaching community's ability to overcome numerous environmental constraints and effectively collaborate on a project.

Personality factors can also influence whether interactions are reciprocal. For example, while autonomy empowers the teacher to make decisions, the teacher may become isolated, avoiding consultations with peers believing that teaching is idiosyncratic, personal, and private (Zahorik, 1987). However, autonomy can also indicate that teachers want to interact in order to gather a variety of ideas from their peers, and determine which ones are most applicable for their classrooms (Grossman, Wineburg, & Woolworth, 2001). Similarly, open-mindedness is valued as teachers talk to one another about various issues (Chene & Sigouin, 1997). If peers are non-judgmental and forgiving, then teachers are more inclined to express themselves to each other. Hertzog (2002), for example, noted that new teachers confronting problems first consult fellow novices, or interpersonal relationships, because they appear more receptive to discussing difficult issues. Finally, since time constraints are widespread, an organized peer can be an asset to provide assistance efficiently and effectively. In professional development and reform, organizational routines, such as structured and routine gatherings, provide familiar mechanisms to foster change and growth (Knapp, 1997).

The six factors influencing reciprocal interactions are not mutually exclusive. It remains unclear how specific attributes catalyze others, or whether critical combinations are needed to induce reciprocal interactions among a community. For example, the introduction of tools and resources in an environment in combination with motivated teachers influences reciprocal interactions in a community. Other factors are more difficult to change, such as beliefs and personality, raising doubts as to whether reciprocal interactions can be stimulated in less-than-ideal ideal communities. It is important, therefore, to optimize approaches designed to promote reciprocal interactions to facilitate professional development and address the ongoing support needs of teachers.

Collaborative Apprenticeship and Situated Professional Development: A Model

We have argued that reciprocal interactions, in the context of a supportive community of practice, are needed to overcome professional development barriers. Table 1.3 illustrates how professional development can be facilitated through collaborative apprenticeships within the context of a teaching community and the roles assumed by teacher-leaders and peers during the process; Figure 1.1 depicts the progressive nature of the collaborative apprenticeship.

Insert Table 1.3 Figure 1.1 Here

The Collaborative Apprenticeship model incorporates four progressive professional development phases: introduction, developmental, proficient, and mastery. The introduction of a new instructional strategy or resource follow the initiative of a teacher-leader motivated to mentor peers, and a community of peers sharing a common goal to learn and develop new ideas (Keedy, 1999). The introduction can occur during a departmental meeting, a common planning period, or an inservice teacher workshop. During this period, the teacher-leader models the implementation of a new instructional method or resource to peers who initially reflect on and discuss skills and strategies needed in their development. This is analogous to Feiman-Nemser's (2001) examination of qualities of an exemplary support teacher, who noted the importance of giving "living examples" and modeling "wondering about teaching" to novices. The development and implementation of the learning activity in this phase is primarily driven by the teacher-leader as indicated by the high density of points, with little contribution from the peer-teachers as indicated by the low density of points, in Figure 1.1.

Modeling, as noted previously, is important to professional development and a means to promote reciprocal interactions. Modeling describes the observable characteristics of effective design and instruction, but more importantly the thinking strategies more capable peer uses to create the activity and learning environment. The modeling of activity for an actual classroom learning environment is important because teachers prefer to learn new tools and strategies as intended for use in *their* classroom (Little, 1994; Smylie, 1989).

The developmental phase involves the teacher-leader and peer-teachers as a collaborative team in the design, development, and implementation of learning activities that involve new instructional strategies or resources. In contrast to many professional development opportunities, the teacher-leader is mutually engaged with, and follows the progression of, peer-teachers as they develop learning activities (Swan et al., 2000). Rather than promoting skill mastery prior to implementation, the teacher-leader legitimizes the participation of less experienced peers by engaging them collaboratively in the development of learning activities. This collaboration occurs in planned and informal meetings to establish and support an ongoing and sustained professional development effort.

Successful peer collaboration occurs when teachers share ideas and support each other's learning through discussions surrounding similar interests and goals (McCotter, 2001). The teacher-leader initially assumes responsibility for managing the design and development process, then scaffolds and coaches the peer-teacher's development and assists the novice in performing a task. In a professional development effort, the teacher-leader and peer-teacher mutually engage a common task, in which the peer gradually becomes more capable and assumes more responsibility until becoming autonomous.

This transition in responsibility and participation is illustrated in the developmental phase of Figure 1.1, where the density of points gradually shifts for both the teacher-leader and the peer-teachers. Coaching in the developmental phase refers to the observational and facilitative efforts of the teacher-leader to support and encourage peers as they design and develop instructional strategies. Mutual responsibility and continual feedback occur reciprocally in coaching. Hence, in professional development efforts, collaborating teachers provide feedback to their design and instruction, thereby sharing responsibility for each other's performance.

The proficient phase of Collaborative Apprenticeship involves peer-teachers autonomously developing learning activities. As shown in Figure 1.1, the primary responsibility for design, development, and implementation of learning activities has shifted to the peer-teachers. They demonstrate the capability to create learning activities for their classrooms without direction from the teacher-leader, who assesses the peer-teachers' work, and offers suggestions for improvement and further exploration. Browne and Ritchie (1991) described this process as "empowerment" of teachers because they take responsibility for the direction of their ideas and seek critical feedback from their peers.

In the proficient phase, peer-teachers explore different uses of the instructional applications, distinguishing when and how the strategies are useful in their learning environments. This parallels the articulation phase in cognitive apprenticeships (Collins, Brown, & Newman, 1989), where learners verbalize their thinking so they can generalize knowledge and generate heuristics. Articulation can help teachers to develop and justify strategies for alternative activities in their learning environment. In professional communities using reciprocal interactions, teachers articulate their thinking and experiences by sharing stories with one another. They explain what they did and how they accommodated special learning conditions, such as learning disabilities, access to technology, and time constraints. As a consequence, the shared knowledge, experience, and learning activities can be used in multiple classrooms within the community. As ideas develop based on successes in their classrooms, social affirmation is shared among teachers. They develop richer conceptualizations about effective design and implementation strategies, likely to boost confidence and motivation to continue effort and improve learning.

Most professional development models focus on immediate development, with little or no attention to sustaining use of strategies and resources. However, relationships and roles among individuals within a community evolve over time. As individuals come and go, new opportunities and challenges are confronted, and new ideas emerge. Therefore, professional development models need to account for changes among community participants. During the mastery phase of Collaborative Apprenticeship, peer-teachers have transformed from peripheral to central participants (Lave & Wenger, 1990) in developing learning environments with new approaches in their teaching community. Caverly, Peterson, and Mandeville (1997) described this as second and third generation mentors, where each protégée, in turn, mentors a new set of peers. Hence, they become capable of leading and supporting a new cohort of teachers to design, develop, and implement activities needed to sustain the efforts, that is, they become teacher-leaders. Since different resources and instructional methods are used, teachers assume different roles within their community. An individual can simultaneously act as a teacher-leader for the development of learning activities with a particular method, and an apprentice when learning another resource or strategy. As a consequence, teachers engage in multiple partnerships based on sharing repertoire and assuming responsibility for each other's learning and development.

The flow and progressive nature of the Collaborative Apprenticeship is illustrated in Figure 1.1, providing a systemic view of how the community enacts the model. Since a community of teachers has a variety of skills and experiences, there is no single entry point into the model. Peer-teachers need not participate in introductory lessons if they have already learned how to use a resource or instructional method and have seen it modeled effectively. However, teachers may still need support to design and develop instructional activities that integrate the resources or utilize the new methods. In this case, a peer-teacher begins at the developmental phase. The teacher-leader works closely with a small group of peer-teachers in the design process through collaborative brainstorming and planning sessions. Their newly developed learning activities go through several iterations until the group decides to implement them. The teacher-leader provides feedback and offers suggestions proven effective for his or her own classroom instruction, and the team of teachers discusses accommodations to alternative learning needs.

After implementation, peer-teachers reflect and discuss their findings and observations, and propose changes for future classroom use among all members of the community. Through successive activities, peer-teachers involvement gradually increases until they demonstrate proficiency and preparedness to mentor other members of the community, ensuring sustainability of new methods or resource use within the community. During the mastery phase, the peer-teacher becomes a teacher-leader able to mentor other teachers, still relying on advice from current and past teacher-leaders. Hence, support is both ongoing and distributed throughout the community.

Through mutual engagement, participation is balanced and shared among teachers of the community. A given teacher may have central participation in one professional responsibility, such as designing calculator-based labs, and have peripheral participation in a different venue, such as designing interactive geometry learning activities. Within the community, different facets of professional development are based on the needs and capabilities of individual teachers, enabling ongoing opportunities for various forms of participation and contribution to shared community goals.

Collaborative apprenticeships in teaching communities, then, provide a means to sustain professional learning efforts by utilizing reciprocal interactions and addressing the primary support needs of teachers— onsite, ongoing, and "just in time." The model emphasizes the importance of legitimizing the participation of all members of the community through collaborative efforts, based on their expertise, so that all teachers contribute to shared goals. Effective leadership is necessary to orchestrate and support such a vision. Leaders do not solely manage, but also participate in the culture of learning and development with their teachers, treating them with respect as peers and colleagues (Klein-Kracht, 1993). They model positive behaviors, demonstrate teaching, participate in team building, and provide support to teachers (Huffman, 2000). Collaborative Apprenticeship also requires the investment of strong teacher-leaders, those who support by being an advocate, and lead through example, guidance, and communication (Hurst & Reding, 2002). With the investment of effective leaders, the situated professional development effort (Swan et al., 2000) promotes learning as a continual activity that is both natural and expected of the teaching community.

Implications

In the Collaborative Apprenticeship model, an expert or mentor initially leads a community of teachers toward the design and development of learning activities. The expertise and experiences required of such a leader, however, are not well defined. An individual may be more knowledgeable or experienced than her colleagues, but not necessarily able to develop and extend other teachers' use of instructional settings. Thus, research is needed to examine the factors needed to mentor teachers—initiative, preparation, and the like— to implement a Collaborative Apprenticeship model. Furthermore, we need to better understand how leadership and teacher attributes influence the collaborative apprenticeship experience—for both mentor and apprentice.

The role and potential of reciprocity in teaching communities also warrants additional study. Much of the research about reciprocal interactions in learning environments has focused on acquiring skills rather than improving practice. Although individual teachers may vary in their instructional practices, the collective wisdom of the teacher community draws upon a far vaster set of experiences concerning curriculum and instructional strategies. Different combinations of reciprocity factors may stimulate interactions among a community of teachers not possible for a given individual. Efforts to promote reciprocal interactions among a professional community, such as teachers, may elicit qualitatively and quantitatively different learning and development than for non-professional communities.

We must also better understand the culture and organization of schools in order to provide opportunities for teachers to engage in reciprocal interactions. Currently, many environmental barriers, such as failure to provide a centralized teacher office and common planning periods, provide formidable obstacles to improved practice. Few teachers have adequate preparation or collegial time to develop as a community. Rather, “planning time” is provided as segmented blocks of time that are rarely aligned with colleagues who teach the same subjects or grade levels. Consequently, reciprocal interactions affecting learning and performance are more likely to take place during occasional professional development days or outside of the school day during unscheduled time. As noted previously, this decontextualization can be detrimental to both becoming proficient in adopting instructional methods and to the evolution of a sustainable, supportive community of professional teachers.

We also need to examine how teachers transition from peripheral to central participants as community members. Professional development will likely continue to be ineffective until teachers assume greater leadership roles for learning in their teaching community. Although communities need to initiate integration efforts under the tutelage of an expert-mentor, community members must assume responsibility to be mutually engaged and embrace joint enterprise in shared goals for multiple experts to emerge over time.

Finally, we need to refine our understanding of how reciprocal interactions influence professional learning. Although we have suggested these factors are interdependent, some elements may catalyze the development of other elements. For example, elements of the affective domain, such as caring, patience, and sensitivity, may influence dispositions to engage in story-telling, sharing ideas, and resolving conflict. A closer examination and analysis of reciprocal interactions is needed to reveal potential relationships.

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Table 1.1

Potential reciprocal interactions in a community of teachers.

Interaction	Sources	Purpose
story telling	Orr, 1990; Rust, 1999	Make sense of training; Understand urban teaching
backscratching	Lee, 1999; Waugh, Levin, & Smith, 1994	Exchange cross-cultural content; Participate on peer projects
discussing and resolving conflict	Palmer, 1993; Zahorik, 1987	Address critical moments; Overcome instructional challenges
brainstorming	Hasbrouck & Christen, 1997; Korineck & McLaughlin, 1996;	Generate ideas and solutions; Reflect on classroom observations
giving and seeking advice	Hertzog, 2002; Selwyn, 2000	Cope with instructional problems; Pose questions to peer experts
modeling	Chene & Sigoun, 1997; Kohler, Ezell, & Paluselli, 1999	Illustrate cognitive strategies; Demonstrate instructional strategies
sharing ideas	Clement & Vandenberghe, 2000 Zahorik, 1987	Exchanging instructional materials Share classroom experiences
motivating and reinforcing	Hall & Davis, 1995	Encourage improvement and disposition
posing and responding to task-based questions	Zahorik, 1987	Transfer knowledge and skill across community members

Table 1.2

Domains and factors affecting reciprocity

Domain	Factors	Sources
Affect	caring	Chene & Sigouin, 1997; Silva & Tom, 2001
	anxiety level	Hawkey, 1997; Manouchehri, 2001
	patience and sensitivity	Waugh, Levin, & Smith, 1994
	enjoyment	Kohler, Crilley, & Shearer, 1997
	connection to a group	Grams, Kosowski, & Wilson, 1997
	friendly climate	Chene & Sigouin, 1997
	connection to an individual	Hall & Davis, 1995; Manouchehri, 2001
	respect	Dillon & Stines, 1996; Terehoff, 2002
Beliefs	teaching	Arnn and Manigeri, 1984; McCotter, 2001
	learning	Manouchehri, 2001
	instructional design	Carr, 2002; Rogers, 1999
	social obligation	Silva & Tom, 2001
	self-efficacy	Bandura, 1986; Hall & Davis, 1995
Environment	proximity	Brown & Duguid, 1991; Rossman, 1984
	shared time	Clement & Vandenberghe, 2000; Zahorik, 1987
	individual time	Hunter, 2001; Lohman, 2000
	human resources	Sandholtz, Ringstaff, & Dwyer, 1994
	physical resources	Lohman, 2000
	accessibility	Nisan-Nelson, 2001
Culture	leadership	Carr, 1997; Keedy, 1999; Palmer, 1993
	professionalism	Davies, Brady, Rodger, & Wall, 1999
	curriculum	Garet et al., 2001
	mutual responsibility	Showers, 1985;
	peer feedback	Kohler et al., 1999
	shared tasks	Jarveka, Bonk, & Lehtinen, 1999
Cognition	common understanding	Hausman & Goldring, 2001
	priority	Zahorik, 1987
	awareness of learning behaviors	Arnn & Manigeri, 1994
	lower order thinking	Hertzog, 2002; Manouchehri, 2001
	higher order thinking	Little, 1982; Clement & Vandenberghe, 2000
	reflection	McCotter, 2001
Personality	assertiveness	Lohman, 2000; Zahorik, 1987
	motivation	Franke, Carpenter, Levi, & Fennema, 2001
	responsibility	Hunter, 2001
	autonomy	Grossman, Wineburg, & Woolworth, 2001
	availability	Sandholtz & Wasserman, 2001
	open-mindedness	Chene & Sigouin, 1997
	organization	Knapp, 1997

Table 1.3

Phases and roles to promote collaborative apprenticeships for professional learning in teaching communities.

Phase	Teacher-Leader Roles	Peer-Teacher Roles	Collaborative Partnership	Related Sources
Introduction	Promotes and models use of strategies in workshop or classroom environments	Observes and participates in learning applications of new methods	Discuss and reflect on teaching and learning experience	Fairbanks, Freedman, & Kahn, 2000; Feiman-Nemser, 2001
Developmental	Provides scaffolding, coaching and fading to design, develop, and implement learning activities	Acquires skills and strategies in context of participation	Collaboratively design, develop, and implement learning activities	McCotter, 2001; Swan et al., 2000
Proficient	Identifies areas for improvement and exploration	Articulates understanding by autonomously designing activities	Share experience and ideas with peer community	Browne & Ritchie, 1991
Mastery	Observes and participates in learning applications of new methods	Promotes and models use of strategies in workshop or classroom environments	Peer-teacher becomes teacher-leader for design and development of learning applications	Caverly, Peterson, & Mandeville, 1997

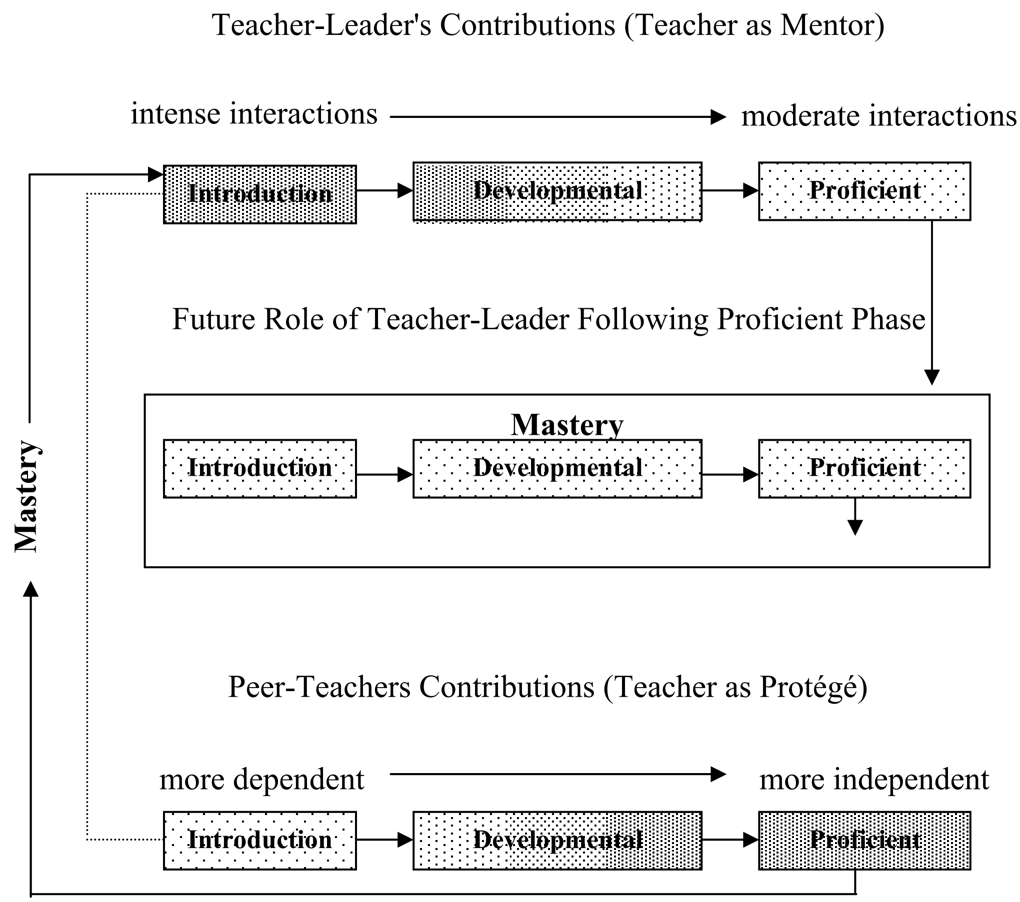

Figure 1.1. A community of teachers as collaborative apprentices in professional learning.

CHAPTER 2

PROMOTING TECHNOLOGY INTEGRATION THROUGH COLLABORATIVE APPRENTICESHIPS[2]

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[2] Glazer, E. M., & Hannafin, M. J. Submitted to *Educational Technology Research and Development*, 6/12/03.

Abstract

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, onsite, 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 a feasible approach to promote technology integration. Teachers with experienced technology use serve as mentors of technology applications aimed at improving instruction. Technology is gradually infused through the curriculum as teachers learn to design technology-rich lessons from their technology-savvy peers through modeling, collaboration, and coaching.

Promoting Technology Integration Through Collaborative Apprenticeships

Although schools acquire new technology each year, it is rarely well integrated into classroom practices (CEO Forum, 1997). 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 inservice programs also contribute to this trend (Office of Technology Assessment, 1995). Practicing teachers often learn "about" technology outside of their classroom environment, frequently 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 become more abstract and less meaningful (Brown, Collins, & Duguid, 1989). Consequently, when teachers return to their classrooms, they are often unsuccessful in their technology integration efforts because they lack concrete experience in *their* instructional settings addressing *their* instructional needs. Furthermore, teachers often report difficulty implementing what they have learned because they lack support to sustain their efforts (Schrum, 1999). Simply making technology available and offering training rarely promotes successful technology integration; it may be necessary, but it is clearly insufficient.

An alternative approach to technology integration, Collaborative Apprenticeship, utilizes a professional development model situated in the context of the school environment (see Glazer & Hannafin, 2003). Teachers can obtain onsite, continual, and 'just in time' support from peers when professional learning is integrated into the community's repertoire. The model utilizes the intellectual resources and skills of a given teaching community through the establishment of mentoring partnerships.

Overcoming the discrete learning experiences of technology-intensive workshops, teachers can provide continuous support during the school day to their peers in order to monitor their growth in designing, developing, and implementing effective practices.

This paper focuses on improving technology integration by cultivating professional teaching communities that are situated in school environments. The goals are to: 1) introduce the Collaborative Apprenticeship model and its theoretical framework, and 2) describe how the model enables ongoing support for technology integration efforts. We begin describing the context of teaching that is especially problematic for technology integration efforts. Then, we discuss conceptual underpinnings of collaborate apprenticeship, such as the importance of reciprocity and communities of practice. Finally, we investigate how Collaborative Apprenticeship can be used to support technology integration.

Teaching and Technology Professional Development in Context

Teachers are bombarded with numerous tasks and responsibilities each day. In addition to teaching, they plan lessons, grade papers, complete administrative paperwork, tutor students, and manage the lunch room or study hall. Time for professional learning must be well-organized because teachers are limited to few moments where they can explore, reflect, and support—processes needed for any meaningful activity but especially to integrate technology seamlessly, efficiently, and effectively (Hunter, 2001). However, many teachers are willing to expend additional time and energy when they see positive learning effects with their students; they are, in turn, more likely to sustain and enhance their efforts (Holahan, Jurkat, & Friedman, 2000). Increased motivation appears to overcome time limitations during the school day, but is not necessarily pervasive throughout the teaching community. Teachers who are unsuccessful initially quickly become discouraged, tending to abandon the technology innovation and motivation to learn effective uses.

One way to address this dilemma is to form community-wide goals where peers depend on each other in their learning (Hausman & Goldring, 2001). Innovative ideas are shared, and more importantly, design and development strategies are gradually acquired across community members through collaboration. In order to develop effective and interesting approaches, teachers need ongoing, sustainable support to ensure their value (Honey & Henriquez, 1993; OTA, 1995; Schrum, 1999). Obtaining such support demands ongoing interactions, where peers can discuss and learn from successes and failures in the classroom (Boyd, 1992). In essence, teachers need a strong collegial environment to integrate technology effectively, one where they can share ideas, model best practices, ask difficult questions, and support one another when it is most needed.

Reciprocity in Professional Development

Effective collegiality involves reciprocal relationships, where teachers willingly support the cognitive and affective needs of peers (Chene & Sigouin, 1997). In such partnerships, learning involves two-way support where interactions are reciprocal. Reciprocal interactions are encounters demonstrating and influencing mutual support for teacher learning and development (Glazer & Hannafin, 2003).

Many reciprocal interactions in professional development initiatives involve technology use. For example, Waugh, Levin, and Smith (1994) noted that teachers use a "backscratching" approach, where teachers collaborated under the condition that others would contribute to their work, by recruiting participants to their network projects. As a result, many teachers became involved in two or more collaborative projects, organizing one and assisting in other efforts, similar to the Learning Circles of AT&T's Learning Network. Lee (1999) observed backscratching in a distance-learning initiative across different countries. In this study abroad program, students from different countries exchanged instructional content as a mechanism to learn about their different cultures.

Among teachers with a common professional interest, Selwyn (2000) examined the type of advice requested and shared electronically among special needs coordinators. Teachers posed and responded to questions to the group about policy issues, resources, professional development and problem situations at their schools. Story-telling was used to compare experiences across schools, vent frustrations, and strengthen relationships by empathizing with one another. Due to its mutually supportive nature, the authors drew parallels to a school staff room in that participants became attached to the forum with a sense of community.

The Apple Classrooms of Tomorrow project involved multi-year school-wide technology integration efforts in several schools. Sandholtz, Ringstaff, and Dwyer (1994) suggested that collegial interaction changed over time as teachers transformed their instructional practices. Emotional support and technical assistance were prevalent during early phases when teachers were introduced to new tools and using a computer. Emotional support involved sharing frustrations and successes through story-telling, and motivating teachers to continue their use of technology through ongoing encouragement. Technical assistance encompassed posing and responding to task-based questions as teachers discussed strategies on how to locate software and manage equipment. Teachers also shared and collaborated in later phases when they integrated technology into their instructional practices in more creative and innovative ways. Sharing ideas became commonplace as teachers explored uses of technology beyond simple drill-and-practice. Collaboration emerged when teachers used technology seamlessly within their teaching, brainstorming in cross-curriculum team-teaching activities.

In a study surrounding mentoring in a multi-school technology integration effort, MacArthur et al. (1995) described the evolving relationship between mentors and their peers. At first, mentors modeled applications of technology by leading discussions and demonstrating software. Then, coaching and motivating interactions were used to encourage teachers to gradually use technology applications on their own. Teachers and mentors brainstormed ideas and discussed and resolved conflict when they experienced difficulties implementing technology-intensive lessons. Ultimately, interactions between mentor and protégés resulted in collaborative learning as teachers became more competent in their technology integration. One mentor described the process as learning with, instead of training, a peer. Hence, teachers utilized different interactions as they gained technology integration experience and understanding.

Hunter (2001) found that collegiality was a critical factor in a technology integration effort. Teachers reported that their most effective means of learning was through peer interactions rather than external sources. Teachers were placed in small teams across grade levels based on having a shared vision towards teaching and learning. Within the teams, story-telling reinforced how particular tools support instructional strategies in certain lessons. They also shared ideas on how technology applications can increase work productivity. Further, they devised opportunities to use new software in mini-seminars, which involved ongoing posing and responding to task-based questions.

Interactions can support learning and propel technology integration in a variety of ways when they are situated in a learning community. The interactions serve as a critical means to distribute knowledge and strategies across the community. However, it is not clear how community attributes influence interactions. Understanding these influences might improve support for ongoing professional development through well-cultivated reciprocal interactions.

Communities of Practice: Teachers and Reciprocal Interaction

Reciprocal interactions are fundamentally engrained in the every day activities of a community of practice (Wenger, 1998). Community participation involves social negotiation to explore meaning and share understanding among its participants. In a community of teachers, *mutual engagement* implies that teachers have opportunities to influence the progression of activities of the professional community through equal representation. That is, they are involved in designing and developing learning activities, making curricular decisions, and leading their peers in different initiatives. *Shared repertoire*, another attribute of a community of practice, describes the 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 quickly relate to other teachers due to common responsibilities, shared language, and the emotional impact of teaching children and adolescents. *Joint enterprise* involves common principles by which the community adheres, and the common goals to which the community 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 all teachers' benefit.

These three elements are interdependent. For example, when a community of teachers has joint enterprise in the creation of a technology-enhanced curriculum, the process necessarily includes interaction and negotiation about the curriculum's content and instructional activities. The design process draws on teachers' shared repertoire because they need to reflect on current practices in order to develop learning outcomes and appropriate instructional strategies. Mutual engagement is necessary for curricular development because teachers' collaborative efforts involve multiple perspectives and experiences, which often strengthens the quality of the product. Hence, the interactions among communities of practice are reciprocal and mutually supportive.

Important perspectives on the role of reciprocal interactions within communities of teachers can be derived through the study of the adoption of innovations. According to Rogers (1983), adoption progresses through several stages: knowledge, persuasion, decision, implementation, and confirmation. Understanding of and experience with the innovation begins as early as the knowledge stage (Byrom, 1998), and evolves per the context of its use (Brown, Collins, & Duguid, 1989). However, change agents who introduce an innovation represent only a fraction of the overall population (Rogers, 1983), so relatively few implementers are involved in the genesis of an innovation; most teachers implement without the close guidance of those who developed the innovation. In the case of technology integration, using and applying technology requires continual communication and interaction among peers who actually implement innovations (Sterns, 1991). Through well-conceived interactions, innovations are more likely, as well as more quickly, adopted (Sandholtz, Ringstaff, & Dwyer, 1994).

Reciprocal Interactions and Classroom Technology Integration

Technology is not a panacea (NCTM, 2000); it may be a means to some ends, but it cannot, by itself, solve basic educational problems. Media have been described as "mere vehicles that deliver instruction but do not influence student achievement any more than the truck that delivers our groceries causes changes in our nutrition" (Clark, 1983, p. 445). Likewise, technology integration per se may improve or worsen teaching and learning. Advocates, in turn, call for “effective” and “appropriate” technology integration.

What, then, defines effective and appropriate technology integration? To some, providing sufficient hardware, using technology in the classroom with little difficulty, or creating interesting projects are measures of technology integration effectiveness. In the context of this paper, technology integration requires that the community of teachers be able to design and implement technology-enhanced learning activities consistent with instructional goals, while ensuring that technology enhances learning opportunities, such as supporting learners, developing alternative perspectives, enabling visualizations of complex concepts and dynamic representations. A teacher who fails to understand how and why technology can be useful is unlikely to integrate technology effectively. Mindful development and use of instructional strategies in technology-enhanced settings will help teachers to integrate technology effectively.

Many technology training programs, however, tend to emphasize the mechanics of the tool and learning of software programs over mindful instructional applications. Tool facility is important in understanding its capabilities and limitations, but teachers also need to create and manage technology-enhanced learning environments. They need support to understand how affordances of specific technologies can promote instructional strategies (Kozma, 1994). For example, spreadsheet and database tools engage students in critical thinking because students can generate and organize their own representations (Jonassen, Carr, & Yueh, 1998). These are powerful tool uses relying on deep understanding of technology's pedagogical potential. Where do teachers receive such support? How do they maintain their ongoing responsibilities while simultaneously developing new tool facility and support for their integration?

Some may argue that teachers need to learn technology tools outside of the school environment to avoid being overwhelmed with a myriad of tasks presented during the school day. However, while this approach may support teachers enrolled in a particular course or workshop, it does not offer support during the school day and when needed. Alternatively, teachers can obtain ongoing support if they develop instructional materials in the context of their teaching environment, because they can revise, discuss, and improve their practices among a community of professionals who are regularly accessible.

Successful technology integration requires the observation of effective practice, on-site support, just in time training, and continual training (Byrom, 1998; Holahan, Jurkat, & Friedman, 2000). Communities promoting reciprocal interactions address these needs in several ways. First, teachers observe and experience effective technology integration in their schools because "learning and cognition are fundamentally situated" (Brown et al., 1989). A concrete example can give teachers a framework to develop instructional ideas and reflect on a situated experience or theory in practice (Lave & Wenger, 1990). Modeling also addresses this need. Teachers can observe one another in classrooms to understand the learner perspective, and reflect on the experience to provide feedback to the teacher and to develop strategies for their own activities (Manouchehri, 2001).

Next, teachers need on-site support in order to become comfortable and confident that they will receive assistance in a timely manner while they become increasingly capable. Teachers have little time available to troubleshoot technical difficulties or sift through manuals to acquire basic software skills (OTA, 1995); indeed, they are likely to abandon efforts if timely support is not forthcoming (Guhlin, 1996). The nature of support, however, should focus on skills and strategies that ultimately enable the teacher to perform autonomously. When support is provided without intent to empower, the teacher may become unduly dependent on external support to accomplish their work. Instead, teachers need to use each other, and external support, to improve their understanding and use of technology. Proximity, an environmental factor of reciprocal interactions, is essential to providing on-site support. When teachers are mutually engaged in shared learning experiences, they have greater proximity and access to one another, and a greater likelihood of supportive, reciprocal actions.

Third, teachers need “just in time” training, that is, support on demand. In professional and situated environments, much learning occurs when it is necessary to complete a task (Brown et al., 1989). For example, in a summer workshop focusing on applications of mathematics software, teachers will likely engage in activities from various areas of the mathematics curriculum. However, they will not use all of these activities in their classroom and may wish to modify them to meet their teaching needs. Worse, they may not recall their summer learning experiences at the moment in which they could apply them to instructional activities used when school is in session. Conversely, during the school year, teachers will likely tailor their lessons and professional learning directly to their instructional needs, addressing curriculum issues and students' learning. For example, 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 "just in time" learning, teachers might have the opportunity to develop ideas and learn from peer-teachers who currently teach the same concepts, demonstrating the need and utility for reciprocal interactions in a situated experience.

Finally, teachers need continual training, not single seminars or workshops, in order to develop and deepen their understanding of technology integration (Schrum, 1999). Workshops often provide only an isolated introduction to uses of a technology, while teachers need gradually more challenging learning opportunities to expand their facility in teaching with a particular tool. While improving tool facility, there is little opportunity to “try out” and evolve approaches that address both teacher individual needs and the unique situational demands of their classrooms. Instead, opportunities to reflect on experiences are needed after initial implementation so teachers can ultimately act on their own needs and situational demands. This support may best occur in the everyday context of schools where teachers can interact during shared time and space.

Technology integration, like other facets of teaching and learning, can be complex and multidimensional. Several studies have demonstrated the value of cognitive apprenticeship (Collins, Brown, & Newman, 1989) models to support and enhance technology training (Cash, Behrmann, Stadt, & McDaniels, 1996; Chyung, Repman, Lan,

& Winiecki, 1997; Snyder, Farrell, & Baker, 2000; Wilson & Heckman, 1992). Collaborative Apprenticeship, an adaptation of Collins, Brown, and Newman's cognitive apprenticeship (1989), is a professional development model that supports teacher learning in a professional teaching community during the school day [See Glazer & Hannafin (2003) for a detailed description of the Collaborative Apprenticeship Model]. Experienced teachers mentor their peers, using modeling, scaffolding, and coaching techniques, until teachers are autonomous in their design, development, and implementation of new learning materials. In return, peers challenge existing ideas and contribute new lessons to benefit the collective's activities. Teachers learn from and respond to each other's needs through interaction opportunities, such as shared planning, because they have access to support that is onsite, ongoing, and 'just in time.'

The Collaborative Apprenticeship:

Professional Development in Context

Technology integration barriers can be overcome using reciprocal interactions strategically. Reciprocal interactions can be sustained in a community through apprenticeships that strengthen relationships between experienced and novice professionals. Table 2.1 illustrates how participation across teachers with varied expertise can contribute to technology integration and professional development; Figure 2.1 depicts the roles and peer support within Collaborative Apprenticeship.

Insert Table 2.1 and Figure 2.1 Here

The Collaborative Apprenticeship approach seeks to gradually embrace technology integration across the community through introduction, developmental, proficient, and mastery phases. The *introduction* of a technology tool and its instructional applications follow the initiative of a community of peers sharing a common goal—to learn and develop innovative technologies (Norum, Grabinger, & Duffield, 1999). In this phase, a teacher-leader models strategies and demonstrates sample technology-enhanced lessons to peers during shared times, such as a departmental meeting, a common planning period, or an inservice teacher workshop. Teacher-leaders take responsibility for sharing or developing exemplary lessons to provide models for peer-teachers to learn lesson characteristics, while discussing skills and strategies needed to design and develop activities of this nature. These actions not only stimulate interactions to support learning, but more importantly make visible the cognitive processes of a community expert. Further, through authentic classroom activities, teachers learn technology applications that directly tie to *their* instructional practices (Putnam & Borko, 1997). Modeling can be extended to observations within teachers' classes. Kariuki, Franklin, and Duran (2000) stimulated a technology integration by having mentors teach other teachers' classes, providing teachers opportunities to observe how students learn from technology, while simultaneously becoming comfortable with the technology tools.

Teachers transform their roles in the *developmental* phase, where collaboration is essential in the design, development, and implementation of technology-enhanced learning environments. Teacher-leaders work closely with peer-teachers as they develop activities, providing advice and gradually relinquishing responsibility in the design process. This partnership stands in contrast to the diffusion of expertise in many professional development initiatives because learning is situated in the context of the teaching community and the school day (Swan et al., 2000). Further, peer-teachers have opportunities to contribute in legitimate and peripheral forms to the design and development of learning activities prior to mastery so they gradually gain expertise through their participation (Lave & Wenger, 1990). Collaboration among teachers occurs during shared time where teacher-leaders facilitate brainstorming, reflecting on design strategies and implementing development practices. Peer-teachers are coached by teacher-leaders until they gradually become independently capable of developing original ideas and enacting their own technology-rich lessons. A teacher in MacArthur et al.'s (1995) study on computer mentoring described this evolution as a progression of guiding, coaching, encouraging, advising, and supporting. Coaching involves the teacher-leader's efforts to orchestrate the growth of their peers through encouragement and feedback as they design and develop instructional strategies. Hence, in technology integration efforts, collaborating teachers share responsibility for each other's performance when reciprocally sharing strategies and providing continual feedback.

During the *proficient* phase of Collaborative Apprenticeship, peer-teachers utilize these strategies to independently develop technology-enhanced lessons. Responsibility shifts completely from teacher-leaders to peer-teachers in order to demonstrate the capability to create technology-rich lessons without the teacher-leader's scaffolding. The teacher-leader is not removed from the partnership, but instead evaluates the peer-teachers' work and provides alternative directions for lesson outcomes. Browne and Ritchie (1991) describe teacher "empowerment" as peer teachers gain ownership in their development. Further, peer-teachers explore how technology tools used in one capacity can be used in others, articulating when technology addresses particular learning outcomes and articulating strategies to select appropriate tools for different learning methods (Collins et al., 1989).

In teaching communities, story-telling provides avenues to articulate when, how, and why particular tools are used. Through reciprocal interactions, many teachers use these stories to select and design lessons that reflect their instructional goals. Once ideas from stories are implemented in classrooms, social affirmation or negotiation continues as teachers develop a deeper understanding of technology integration strategies. As a consequence of these interactions, teachers formulate effective design and implementation techniques that improve learning in *their* classrooms. Ultimately, improved lesson design and student achievement boosts confidence and motivation to continue professional learning and development.

During the *mastery* phase, peer-teachers participate centrally (Lave & Wenger, 1990) in developing technology-enhanced learning environments in their teaching community. In essence, a peripheral role has transformed mentoring responsibilities, with capable teachers supporting another generation of peer teachers as they design, develop, and implement lessons. Caverly, Peterson, and Mandeville (1997) found that first generation mentors supported the development of a peer until the peer was capable of mentoring another teacher. By the third generation of mentors, all teachers in the district had developed technology integration skills and strategies. In essence, sustainability of technology integration is enhanced when knowledge and skills are distributed across community members. Each teacher assumes a different level of leadership in the community based on various domains of expertise. An individual can serve as a teacher-leader with expertise in particular instructional method, while serving as a peer-teacher when learning a new tool. 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).

Collaborative Apprenticeship can both address learning needs and sustain technology integration across varied levels of expertise in the community. Teachers need not begin at the introduction phase. In cases where substantial expertise exists, a peer-teacher begins at the developmental phase engaging in brainstorming with the teacher-leader and other peers to support continued learning. Teacher-leaders participate in shared planning sessions to support peer-teachers in designing lesson components, weighing students' learning responsibilities and the teacher's actions. New lessons are reviewed by teacher-leaders and refined by peer-teachers prior to implementation.

After implementation, teacher-leaders orchestrate reflective discussions for peer-teachers as they address critical factors in the lesson’s success, as well as potential revisions for improvement. After several experiences using technology in the classroom, peer-teachers gradually assume more responsibility until they can autonomously design, develop, and implement an activity they originate. Upon “maturating,” teacher-leaders coach successful peers in the mentoring process to sustain the technology integration effort. Hence, peer-teachers transform to teacher-leaders, as teacher-leaders continue to participate on peripherally. Support remains continuously embedded within and distributed throughout the community.

The roles and responsibilities of teachers within Collaborative Apprenticeship are akin to those of a community of practice. Community-wide participation and shared responsibility among teachers supports and sustains mutual engagement. A teacher may have a central role in orchestrating peer learning with a particular tool, but a peripheral role in learning how to incorporate an instructional strategy. Participating in multiple professional learning venues not only diversifies students' 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. Modeling, at both administrative and teacher levels, 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).

Collaborative apprenticeships are a strategic mechanism to sustain technology integration efforts through reciprocal interactions. The model depends on participation and collaboration across the community, and promotes internal leadership from expert practitioners so that all teachers can be invested in the community's shared goals. In addition, the model cultivates onsite, ongoing, and "just in time" support, essential learning needs in situated contexts. The technology integration framework promotes learning as a natural component built into the expectations of the teaching community.

Implications

Several implications are apparent related to reciprocal interactions and their role in promoting technology integration among a community of teachers. Research is needed to determine the effectiveness of Collaborative Apprenticeship as a model for technology integration. The strength of a teaching community and its human and physical resources should be examined closely to identify variables that promote ongoing professional development. We need to examine underlying factors that support interactions so that collaborative apprenticeships can be optimized for technology integration. Issues such as affect, personality, environment, culture, beliefs, and cognition can affect reciprocal interactions and professional learning in different forms

Research is also needed to examine the influence of support alternatives, such as pull-out workshops and en vivo classrooms, to prepare teachers to integrate technology. It is important to examine how different experiences influence skill development as well as attitudes and dispositions needed to sustain technology integration efforts. Further, we need to identify key human and strategy factors that influence teachers' ability to integrate technology effectively, and explore ways to provide such experiences. We may not need to abandon completely one style of professional development in favor of others, but instead examine how they can be used in complimentary ways.

Finally, teachers need useful strategies to support their continued learning of technology applications through Collaborative Apprenticeship. During busy school days, teachers can become distracted from their roles when they lack specific mechanisms to monitor their progress. Teacher-leaders and peer-teachers would benefit from a clearly defined mentoring structure the articulates expectations, feedback interactions, goals, and learning styles. Communication is essential to the relationships between teachers. Clarity in roles and responsibilities across teachers should enhance these relationships and build a sense of trust and mutual problem solving.

Conclusion

Teachers are routinely introduced to new technologies with the promise of enhanced learning, but often receive little support to realize this promise. Teachers and researchers need to pursue approaches to promote technology integration so that the teaching and learning community benefits from collective participation. Reciprocity can overcome support problems in a community of practice through mutual engagement, shared repertoire, and joint enterprise. Given the disappointing state of student achievement and increased pressure to use technology to improve performance, perhaps the time is ripe to cultivate approaches that develop our collective as well as individual capacities.

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Table 2.1

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	Discuss and reflect on learning and design experience	MacArthur et al., 1995; Putnam & Barko, 1997, 2000; Smith & O'Bannon, 1995
Developmental	Provides scaffolding, coaching and fading to design, develop, and implement learning activities	Acquires software and design skills in context of participation	Collaboratively design, develop, and implement technology-enhanced learning activities	Holahan et al., 2000; Kariuki et al., 2001; Swan et al., 2000
Proficient	Identifies areas for improvement and exploration	Articulates understanding by autonomously designing activities	Share 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 et al., 1997

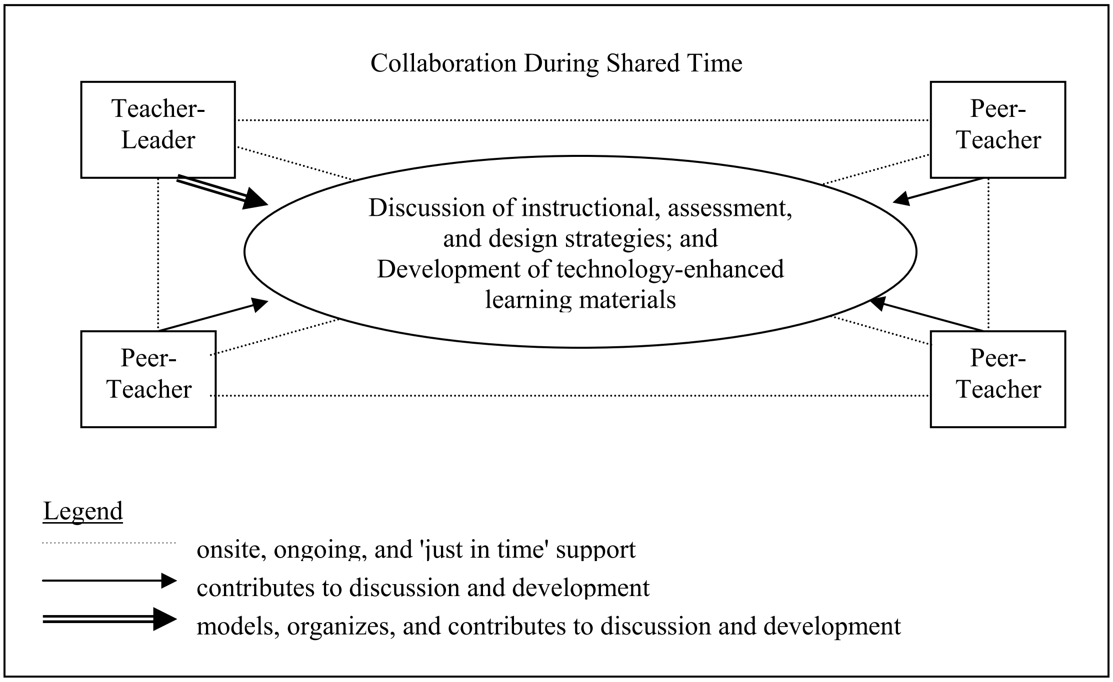

Figure 2.1. Teacher roles when designing technology-enhanced learning materials through Collaborative Apprenticeship.

CHAPTER 3

COLLABORATIVE APPRENTICESHIP:

FACTORS AND RECIPROCAL INTERACTIONS SUPPORTING TECHNOLOGY INTEGRATION[3]

[3]Glazer, E. M., & Hannafin, M. J. To be submitted to the *Journal of Research on Technology in Education*.

Abstract

This study examined the factors and interactions that support teachers' technology integration efforts using a Collaborative Apprenticeship framework. Results suggest that shared planning time, shared curriculum, connection to an individual, expertise, physical proximity, and comfort level influenced interactions across the community of practice. Posing and responding to task-based questions, giving and seeking advice, and sharing ideas comprised more than 70 percent of the observed interactions between teachers. However, the nature of interactions changed as teachers gradually assumed more responsibility in designing technology-enhanced lessons. Teacher-leaders initially modeled exemplar applications of technology-enhanced lessons and gave advice on using them in classrooms; then, the community of teachers brainstormed new ideas in collaborative efforts, and teacher-leaders motivated peers to develop original lessons independently. Implications for collaborative apprenticeships and learning in professional environments are provided.

Collaborative Apprenticeship:

Factors and Reciprocal Interactions Supporting Technology Integration

K-12 technology integration efforts face many barriers. Inadequate training, insufficient human and physical resources, and resistance to change have disillusioned many teachers about technology use in schools (Cafolla & Knee, 1995). Although technology training is sometimes available, many teachers lack confidence that the skills and experiences will transfer to classroom instruction (Marcinkiewicz, 1991). When learning new technologies, educators need follow-up assistance for professional development, such as peer coaching, to integrate new ideas into instructional practices (Sterns, 1991). However, technology support often addresses infrastructure problems, such as maintaining a network rather than helping teachers to use technology in their curriculum (Ronnkvist, Dexter, & Anderson, 2000). Hence, teachers rarely receive the instructional support needed to learn and use technology to improve student learning.

Byrom (1998) found schools with successful technology integration programs provide continual training, on-site and just in time. Financial demands, however, have led some to question the fiscal viability of such programs. Alternatives, such as providing ongoing learning and development within the existing teaching community, may prove both viable and necessary. Teachers can take responsibility and provide leadership for their own and their peers' learning rather than relying on external support (Huffman, 2000; Renyi, 1996). As a consequence, teachers become proactive in their professional development to guide their own learning, as well as to provide timely support to their peers.

Several constructs are especially relevant to improving self-reliance, while maintaining collegiality, among teachers. Shared repertoire, mutual engagement, and joint enterprise strengthen and maintain a "community of practice" (Wenger, 1998). Social construction and negotiation of meaning, collective vision, and shared practices help to sustain communities of practice. These approaches are fundamentally grounded in the interactions between and among community members. When sharing repertoire within a community of teachers, collaboration helps to overcome both instructional and technological challenges by providing mutually supported professional development. Interactions that promote sustainable support are reciprocal (Glazer & Hannafin, 2003), indicating a mutual partnership among individuals contributing to a shared community vision.

It is important to understand how collaborative, reciprocal interactions influence and sustain technology integration efforts. Several staff development (e.g., Browne & Ritchie, 1991) and mentoring (e.g., Holahan, Jurkat, & Friedman, 2000) models have proven effective in integrating technology in K-12 schools. However, few have examined the support teachers give to one another in pursuit of community-wide goals. Sandholtz, Ringstaff, and Dwyer's (1994) research, for example, focused on one-way support of teachers for their own development, but not the interactions needed to sustain the integration of technology across teachers. It is important to examine interactions that are reciprocal in order to understand how communities of teachers support individual needs and sustain technology integration efforts in school contexts. The purpose of this study was to examine reciprocal interactions and factors that influenced those interactions during ongoing professional development designed to support technology integration. Two questions were posed:

- What factors support or hinder reciprocal interactions among a community of teachers during collaborative apprenticeships?
- What interactions support or hinder a community of teachers as they attempt to integrate technology in their classrooms?

In this study, teacher-leaders and peer-teachers used the Collaborative Apprenticeship model for technology integration (see Glazer & Hannafin, 2003, for description and Appendix B for timeline) as a means to provide sustained support within the community of practice. Using the Collaborative Apprenticeship model, teachers gradually became more comfortable with tools and strategies, as well as obtained onsite, ongoing, and just-in-time support from their peers as they learned to integrate technology in their classrooms. Notably, teachers developed technology-enhanced materials in and for their classrooms. Throughout the study, teachers focused on how to facilitate learning in a technology-enhanced environment—their classrooms.

Method

Participants and Setting

The participants were purposefully selected from a K-5 elementary school located in a suburban community in the southern United States. The school, enrolling approximately 1400 students, was selected because it featured peer mentoring, where new teachers were paired with experienced teachers in order to familiarize themselves with the culture of the teaching community. In addition, the school's conception about the mentoring process was in alignment with the teacher-leader role of the Collaborative

Apprenticeship model; mentoring partnerships involved learning instructional strategies, forming collegial relationships, and addressing individual needs (Hertzog, 2002). In addition, the school provided 45 minutes of shared planning time and space during the school day for grade level teachers to collaboratively design, develop, and share learning materials. The fifth grade level was selected because the teachers demonstrated key characteristics of a community of practice (Wenger, 1998): teachers have joint enterprise by striving towards shared goals, share repertoire through similar teaching and learning opportunities, and engage in collaborative efforts involving teachers with a variety of expertise. Teachers often consulted different community members for support and discussion about issues related to curriculum, classroom management, technology use, and the culture of the school. Each member of the community of practice had different strengths that could be used for the group's benefit. Hence, the teachers were able to incorporate the collaborative apprenticeship approach to technology integration by adapting their existing mentoring and shared planning framework.

Prior to the onset of the study, the school experienced changes in its school leadership and teacher corps, resulting in 6 new teachers at the fifth grade among a total of 11. The grade level community lost much of its leadership and experience with technology, including two potential teacher-leaders. Consequently, the technology coordinator volunteered along with one continuing teacher to serve as teacher-leaders.

Two teacher-leaders and nine peer-teachers participated in the study; pseudonyms were assigned to each to protect their identity. Participant profiles, containing information related to tenure at the school and role assumed are contained in Table 3.1. Each teacher-leader had previously designed and implemented successful technology-enhanced activities, mentored other teachers in their development, and expressed willingness to support other teachers through their development. Before the study, the researcher[4] and peer-teachers discussed mentoring techniques, surrounding issues related to peer support, motivation, learning, and goal attainment, upon reflection from these experiences and the school environment. It was assumed these qualifying characteristics prepared the teacher-leaders for the mentoring responsibilities in the study. One teacher-leader, Rebecca, developed considerable technology skills and corresponding instructional strategies through an intensive 40-hour technology-training workshop completed two years prior to the study; the other teacher-leader, Samantha, taught the same 40-hour workshop during the prior five years. Prior to completing the workshop, the teacher-leaders agreed to help peers in their technology use, but were generally unable to provide the needed support. Samantha reported this problem in a research project in a graduate-level course at the university, which then prompted the partnership between the researcher and the 5th grade teachers. Consequently, Collaborative Apprenticeship methods served to formalize peer-to-peer support presumed, but not provided, following the workshop.

Insert Table 3.1 Here

The peer-teachers had not completed the technology training workshop, reported little experience designing technology-enhanced activities, and expressed interest in applying technology in their fifth grade instructional practices. Previously, peer-teachers with little technology experience often fulfilled a school requirement to use the computer lab on a minimum of eight occasions, but did not attempt to enrich the curriculum. In this study, however, teachers were encouraged to design technology-enhanced learning

[4] The researcher is the first author of this paper.

materials specifically to support student learning in their curriculum. Students used technology in creative, purposeful, and reflective ways, such as using the Internet or dynamic mathematical manipulatives, to gather information or manipulate objects on the screen. As an incentive for their involvement, teachers received 2-3 staff development units for their participation.

In this study, the researcher's role was as participant-observer, introducing the structure of Collaborate Apprenticeship to the teaching community of practice, collecting data, responding to the teacher-leaders' thoughts and concerns, and supporting their needs through the mentoring process. Informal interaction occurred occasionally between the researcher and teacher-leaders to discuss individual cases. Reflective sessions with teacher-leaders were held three times during the six-month study when group discourse failed to promote teacher’s further development. The researcher did not offer advice during these sessions.

Research Design

A case study was undertaken based on the nature of the research problem, purpose, and questions. The phenomenon of reciprocal interactions was at the heart of the study, bounded by a technology integration effort within a teaching community of practice. The examination of reciprocal interactions focused on how learning and development were supported through discovery rather than confirmation of an existing theory. Reciprocal interactions and factors, the data measures, were examined through teachers' support needs, collaborative apprenticeship role in the community of practice, and involvement in professional learning activities.

<u>Data Sources</u>

Interviews, observational field notes, and reflective journals were primary data sources (see Appendices in Glazer, 2003, for protocol used in the study; see Appendix C for alignment of each data source and its corresponding research questions). First, an interview preceded the implementation of Collaborative Apprenticeship to characterize participants' knowledge and use of technology, and support for peers' learning and development (see Appendix D). The teachers' technology –in-teaching background derived from the interviews was shared with the teacher-leaders. Throughout the study, informal interviews (see Appendix E) were conducted with teachers when teachers had questions about their participation in the study, and when the researcher needed description and clarification about teachers' activities and interactions. Similarly, reflection sessions (see Appendix F) were used to prompt the teacher-leaders to think about their peers' progress and devise strategies to reach the goal of autonomous development of technology-enhanced activities. A post-interview, following the six-month study (see Appendix G), was given to address the teachers' technology use, identify important factors and interactions, and establish how teachers might continue the technology integration process.

Observational field notes were collected on 15 occasions, each for 90 minutes, to document reciprocal interactions in planning meetings and shared work areas. These observations focused on support needed and provided to integrate technology effectively. The researcher also maintained a reflective journal to document participation with the teacher-leaders and guide ongoing analysis of the field notes throughout the study.

As teachers implemented technology-enhanced activities, they wrote a reflection statement (see Appendix H) about the activity and their planned role in the next development effort. Teacher-leaders each maintained a bi-weekly journal (see Appendix I) that addressed the interactions used to support their peers' development, and strategies for collaborative planning.

Several measures were taken to improve reliability and trustworthiness in the data collection procedures. Brief notes were recorded during each observation and informal interview, and expanded notes were made within one day after each field session. An ongoing journal was created after each field day to document arising issues, ideas, and reflections. Next, an audit trail was used to record the progression from data collection to data analysis (See Appendix J). The credibility of the data is strengthened since the research occurred over a six-month time period through three phases of teacher development, giving time to formulate, check, and recheck assertions. Further, data collection methods were triangulated in order to improve trustworthiness of the data (Glesne & Peshkin, 1992). Hence, there were opportunities to seek clarifications of reciprocal interactions and emerging factors in interviews using observations documented in field notes or teacher journals.

Procedures

Prior to the technology integration initiative, the researcher discussed instructional design and mentoring strategies with the teacher-leaders. These strategies were jointly determined based on collective past experiences in these areas, as well as the culture and expectations of teachers in the community of practice. Within the first three weeks of the study, the pre-interview was conducted with all participants (see Appendix J for timeline), as teacher-leaders noted their peers were overwhelmed with start-of-the-school-year policies and procedures.

The two teacher-leaders agreed to assume responsibility for mentoring teachers in two different groups during different planning periods. In the first group, two teacher-leaders and seven peer-teachers met collectively. The second group met immediately following the first group and involved the technology coordinator as teacher-leader and two peer-teachers. Since the technology coordinator served as a teacher-leader in both groups, she relayed information and ideas between the groups in an effort to improve grade level cohesiveness. Teacher-leaders and peer-teachers met within their groups and discussed potential activities related to the curriculum, incorporated instructional strategies and problem posing to scaffold and stimulate thinking, and used technology to enhance learning opportunities. The number and length of planning meetings was based on the teachers' needs, understanding, and availability. Initially, they met once per week for 45 minutes, and eventually met only once during the last month of the study since they needed more time to develop activities. However, the team scheduled additional meetings in situations where peer-teachers assumed more responsibility to collaboratively design lessons. Additionally, teachers met informally with each other outside of scheduled times to share ideas, give and receive advice, learn different tools, and provide feedback.

Over the six-month study, peer-teachers participated in and contributed to the development of at least eight technology-enhanced learning activities, three of which were original ideas. Teacher-leaders established this criterion based on experience designing technology-enhanced lessons, mentoring teachers to use technology, and the school's requirement to use the computer lab eight times per quarter. However, teacher-leaders were cognizant that peers progressed at different rates through the various phases of Collaborative Apprenticeship due to varied comprehension and motivation. Six of the nine peer-teachers reached the productivity expectation of at least eight technology-enhanced learning activities. The other three teachers remarked they either did not have sufficient time for this effort or did not have the requisite knowledge and skills to reach the expected productivity level. They ceased to participate during proficient phase activities as development of technology-enhanced activities required more individual responsibility.

During planning meetings, teacher-leaders discussed various technology tools that teachers could use in their lessons. While developing instructional activities, teachers were encouraged to use one technology tool within each lesson, and to vary the tools used over the six-month period. The teacher-leaders modeled tools used in past lessons, as well as tools that could be used to address curriculum gaps. As teachers developed their lessons, they chose to continue using the same tool for different curricular purposes, or use a new technology tool for a different learning experience. Careful tool selection was integral in teachers' creation of instructional methods and curricular objectives, as well as the students' learning environments. As teachers gained facility using the tool(s), independently and in their teaching, the teacher-leaders encouraged peers to explore novel uses of the tool. Throughout this developmental process, the teacher-leaders served as "more knowledgeable others" (Vygotsky, 1978), providing advice, strategies, and feedback in an effort to help their peers to reach autonomous productivity. In addition, peer-teachers were encouraged to provide assistance to each other, and rely less on the teacher-leader's support in order to reach their goals. The four phases of Collaborative Apprenticeship, outlined below, elaborate the development process and describe the operational procedures of the study (see Appendix K for a more detailed outline).

Introduction phase. Over an eight-week period, the first three activities were discussed and modeled for peer-teachers during their shared planning period. For example, one teacher-leader presented a lesson on using the Internet to learn about coral reefs, discussed instructional strategies, and shared the lesson plan and student worksheets. The sample lessons in this phase were previously used in a classroom by one of the teacher-leaders, or recommended by an external resource, such as a teaching magazine or an Internet lesson plan database. During shared times, teacher-leaders discussed instructional and design strategies, technology tools, classroom management, curriculum integration, and problem posing.

Developmental phase. The next three activities were created collaboratively during the following eight-weeks. Peer-teachers devised shared goals and assumed more responsibility to develop technology-enhanced activities as a team. One example was an interdisciplinary unit about immigration, where teachers devised an activity in pairs related to a specific content area. Some modeling and sharing from teacher-leaders still occurred, but to a much lesser degree than the introduction phase. Instead, planning meetings involved brainstorming ideas, reflecting on the curriculum and resources, and determining initial strategies for technology-enhanced lessons. Teacher-leaders initially assumed greater responsibility for the design and development of activities by collecting ideas from peer-teachers and modeling how they could be used within a technology-enhanced lesson. As the developmental phase progressed, the teacher-leaders transitioned from modeling and coaching to fading (Collins, Brown, & Newman, 1989), thus shifting peer-teachers responsibility to design, develop, and implement technology-enhanced learning activities. As the mentoring role shifted approximately halfway through this phase, teachers met less often as a group in order to work in smaller teams. Throughout their experience, teachers wrote in their reflective journals (see Appendices H and I) after implementing activities to raise awareness to their understanding, comfort, and readiness to develop. Upon reviewing these reflection statements, the teacher-leaders and peer-teachers determined, in consultation with the researcher, whether the peer-teachers should assume the same or more responsibilities in the design and development process.

Proficient phase. Peer-teachers were given eight weeks to design two more technology-enhanced activities that involved original ideas and increased independence from the teacher-leaders. During this phase, one of the teacher-leaders took a leave of absence for personal reasons unrelated to the study, leaving the technology coordinator as the only remaining teacher-leader for the remainder of the study. Initially, peer-teachers designed collaboratively in small groups without the teacher-leader's guidance. During planning time, peer-teachers met as a group only monthly to discuss progress and ask questions. Even though teacher-leaders encouraged self-reliance in the development of learning activities, teachers were still mutually engaged through different forms. The teacher-leader's responsibility shifted from scaffolding peers' learning to providing support and evaluating lessons. When discussing the teachers' work, the teacher-leader paid particular attention to how learning in the activity connected to the curriculum and standards, and how technology use might enhance student learning experiences. At the end of the study, peer-teachers designed and developed their own activity independently, and then shared their work with the group. For example, one teacher had students devise an advertisement campaign for an old-fashioned product based on information they had gathered on the Internet. The lessons were collected and redistributed by the teacher-leader for use by peers at another time.

Mastery phase. Mastery implies that the peer-teachers were prepared to assume a teacher-leader responsibility with another group of teachers. While this phase was not incorporated in this study, teachers were interviewed at the end of the study to determine the extent to which they were comfortable mentoring technology integration strategies to other teachers in their community of practice.

The teachers' Collaborative Apprenticeship role in developing technology-enhanced activities during the study is summarized in Table 3.2.

Insert Table 3.2 Here

Analysis

Coding

Observational field notes, peer-teacher reflections, teacher-leader journals, researcher reflections, and interviews were coded according to the presence, or lack of presence, of reciprocal interactions and related factors. Codes were tentatively determined through a literature review of research related to collegial interaction, reciprocity in professional communities of practice, and peer mentoring initiatives (see Glazer & Hannafin, 2003). Criteria for assigning codes were initially determined by the researcher, and later modified according to mutual agreement across a research team consisting of six instructional technology doctoral students (see Appendix L for criteria).

The researcher was the data collector on the team; the other members provided input on redefining codes, coding data, and analyzing data, in an effort to enhance the credibility and trustworthiness of the findings.

Coding was ongoing throughout the data collection process; the researcher coded the data while research team members coded samples of different data types to check for consistency in coding assignments. As discrepancies in coding arose, the research team reviewed the criteria and the researcher provided additional background information from field observations. In addition, the coding framework was adjusted to account for unforeseen factors and reciprocal interactions that emerged in the data. When a new code was introduced, the research team reviewed the data and mutually agreed on its name and definition. Due to the large proportion of new codes, the researcher reviewed all of the data at the end of the study and assigned new codes where appropriate.

Organization

The framework used to establish initial interaction and factor codes is shown in Table 3.3. Once data were coded, they were organized into a chart displaying the context, persons involved, data source, and date that highlighted the reciprocal interaction or factor. Over 2200 codes were assigned from the data; some data sources had multiple codes. For example, the observation "Deborah dropped off a folder to Sally with resources on immigration before the meeting. She said that the teachers can use any of the resources." included the following three codes: 1) 'connection to group' because the teachers were involved in different planning groups but wanted the whole grade level to benefit from their work; 2) 'physical resources' because they were exchanging instructional resources; and 3) 'sharing ideas' because they were exchanging ideas that might be useful to the other teachers. The chart was organized in a spreadsheet so that the data could be resorted to address different purposes in the analysis.

Insert Table 3.3 Here

Data were also organized into a frequency table that highlighted the different factors and interactions represented in the data over time. The frequency table portrayed changes in interactions and factors across all teachers influenced by the teacher-leaders' implementation of the Collaborative Apprenticeship framework. Relative frequencies across each category were then tabulated to determine which factors or interactions were dominant over time. Prominent relative frequencies were identified in the table to more closely examine certain data; the numbers alone did not produce conclusive evidence of particular findings. Data with high relative frequency during particular moments of the study were reviewed qualitatively to unveil why and how the interaction or factor was prevalent.

Identifying Thematic Patterns

A thematic approach was used to analyze data, incorporating constant comparative analysis techniques (Creswell, 1998; Strauss & Corbin, 1994). Analysis was ongoing, initially examining patterns emerging in prevalent reciprocal interactions and factors. As data were added to the organization chart, assertions were made to reflect relationships and distinctions in each code category. As data collection progressed, assertions were refined to incorporate new information, or disregarded in the presence of conflicting information. This process continued for each coded category until data reached saturation, where additional data was neither adding to nor refuting the assertions. Upon completion, the organized data were distributed across members of the research team. Each team member generated assertions for a set of assigned codes, and the team subsequently compared them to the researcher's assertions. All discrepancies were discussed and data reviewed again by the researcher to seek resolution to the differences. By the end of the study, over 200 assertions were made to account for the data as represented in the set of coded classifications (see Appendix M).

The research questions were then addressed by clustering the assertions and relative frequency patterns to each of the initial research questions. Within each question, patterns were reviewed in an effort to generate broader, more inclusive assertions that subsume smaller assertions and patterns. Once broader assertions were proffered, the smaller assertions and patterns were reviewed again to determine if they supported the broader findings or further refinements were needed. As the broader findings became more concrete, the preliminary assertions and organizational chart were reviewed to gather evidence to support these claims. Finally, an executive report of the broader findings was shared with the teaching community for a member check. In their response, teachers highlighted particular findings they strongly supported, and questioned two of the broader assertions until they were rephrased for clarity. For example, one finding challenged by teachers related to access to resource materials. Instead, several teachers claimed they simply were not aware resource materials were available to them. Once broader findings were reworded to account for participant interpretation, the researcher reviewed the themes in the preliminary assertions in order to confirm the change.

Findings

Teachers' start and completion levels of development, and factors that influenced development, are contained in Table 3.1; a tabular summary of the findings is contained in Table 3.4 and summarized by key factors and interactions that influenced teacher success.

Insert Table 3.4 Here

Factors

Planning meetings during the school day. An experienced teacher, Michelle, noted the interactions during the planning meeting created collegial opportunities not previously available. She enjoyed "just throwing ideas out, being asked to think of ideas to share with the group, and kind of snowballing or brainstorming on top of that," and valued the idea sharing even when she had nothing to contribute. Bertha reported shared time was valuable because she could easily interact with an experienced peer, Samantha, who offered ongoing ideas and suggestions. Bertha asked for advice on instructional design strategies, such as sequencing class activities, and help to overcome technological challenges, such as reformatting a document she needed for class. The teacher-leader viewed shared time as an opportunity to participate alongside teachers during their planning to give "relevant help when discussions would be happening spontaneously."

Simply having shared time, however, was not sufficient to promote reciprocal interactions. Without structured planning, many worked independently on lessons and grade assignments, and some collaborated or sought assistance from their peers. In addition, the common meeting was sometimes counterproductive if it did not address the teachers' needs. For example, Deborah described the planning meetings as "a waste of time" because teachers sometimes became sidetracked. Since time was designated for technology issues, Deborah expressed disappointment that her interests and questions were not addressed on these occasions. Another teacher, Stephanie, was unable to develop ideas during the meetings for concern about other demands. She perceived a need to be creative at the meetings, which instead occurred more naturally and spontaneously when not restricted by the pressures of a school day.

Teaching beliefs affected contributions during shared time. For example, Chandra expected the teacher-leaders' lessons would provide more guidance and direction for students' learning. She said it was difficult to become involved because the lessons were

> …vague. They had a vast amount of information to look through. Most of the kids are not gung ho, even if it is technology, they are rather lazy. They do not want to sit there, and read through things and get examples that you need. That was the problem.

Chandra's use of computer laboratory time involved practicing typing skills and using skill-based mathematics games. In a reflective session, one teacher-leader speculated Chandra's limited involvement was one of teaching philosophy, but remained confident in her ability to share ideas and eventually become more involved.

The lack of shared time also hampered interactions. The two teachers with a different planning time reported a sense of isolation. Colette, a teacher in the smaller group who had previous experience with grade-wide planning, felt that her team was "out of the loop." She preferred to interact in the whole group setting to gain a greater sense of awareness and contribute to their collective ideas. On one occasion, Colette obtained a substitute teacher for her class in order to attend and contribute to the larger group planning session. However, this was a temporary solution. It became commonplace to seek peer interaction outside the school day in order to share ideas and offer support.

<u>Motives</u>. Curriculum, connection to an individual, expertise, and physical proximity influenced interactions. When teachers had questions about curriculum, they intentionally sought others who taught the same content area to brainstorm and share ideas. One time, several new teachers had questions about the social studies curriculum, so a more experienced teacher, Bertha, took initiative to create a forum for exchanging ideas and developing strategies. Bertha later displayed an attitude of social obligation in an interview to explain her coordination efforts by saying "…other people have done it for me, and I want to do it for them." Further, discussions involving curriculum topics not used by all teachers tended to deter interactions. Whenever social studies or science activities were discussed, only half the teachers benefited because each taught only one of those subjects. Teachers not engaged during these planning sessions were often completing other tasks, such as reviewing their calendar and completing field trip forms, while others contributed to the lesson. Thus, common curriculum served as a shared repertoire for these teachers, whereby interactions created greater awareness and knowledge across community members. Lack of the shared repertoire, however, compelled individuals to focus on individual responsibilities.

The development of interpersonal relationships increased the comfort level for some teachers to share stories with each other, as well as to seek and offer assistance. Roger, for example, volunteered his curriculum experience in social studies due to his close friendship with Rebecca who did not teach the subject. Tabitha was uncomfortable in the school environment, having recently arrived from a different culture, but was open to learning from Colette because of their friendship. Although Tabitha felt uncomfortable with the pace and language used in the planning sessions, she enjoyed learning how to use the computer from Colette. The relationships among teachers built a sense of trust, where peers supported each other's development. One teacher, Tara cited her connection with Deborah as first year teachers made her feel comfortable to talk freely about their experiences and concerns: "I think because we have the willingness to be open with each other. We can realize that we are doing something wrong because our kids aren't getting it." They also formed this connection based on being relatively young, teaching the same curriculum, and "feeling like sisters."

Peer teachers interacted with expert sources outside of the shared planning meetings when they needed support, were seeking advice, or were trying to resolve conflict. Since the focus of this effort was on technology integration, many interactions occurred between the technology coordinator, Samantha, and the various fifth-grade teachers. Samantha primarily assumed a support stance by responding to teachers needs, and initiated interactions if a teacher did not meet a requirement or experienced difficulty in the computer laboratory. In addition to her reputation as being a "human encyclopedia," teachers often sought Samantha because they "respect a lot of what she has to say." During the previous year, her peers named Samantha "teacher of the year" for her contributions to the school. Rebecca, the other teacher-leader who was also nominated for teacher of the year, supported peers on technology issues outside of planning meetings, but in different ways. Rebecca often provided examples of lessons and worksheets or helped teachers make curriculum connections.

Physical proximity also influenced reciprocal interactions. Most teachers reported they interact informally with teachers who are "close by" because they are "convenient." When interviewed, however, the teachers described the different strengths of their nearby peers. For example, Tara appreciated Chandra's teaching experience, Roger's knowledge of the social studies curriculum, and Rebecca's understanding of technology. Roger noted that the four teachers in the cluster have different personalities, but found ways to support one another on different levels. Proximity influenced interactions when their surrounding peers had a relationship with them, a common curriculum topic, or expertise in an area. When these conditions did not exist, proximity did not generally influence interactions apart from promoting personal relationships. Some teachers reported they had no close relationship with a nearby peer, so many sought advice from the technology-coordinator who was located in a different hallway.

Anxiety and comfort level. Teachers were interested in experiences that increased their comfort in integrating technology, but at times were confounded by increased anxiety. The daunting dilemma of bringing a class to a laboratory and confronting a problem they could not resolve heightened anxiety and reluctance to use technology for several teachers. In an effort to increase their comfort level, new teachers Stephanie and Tara requested more hands-on experiences using technology tools in planning sessions so they could review resources and anticipate potential student questions. During post-interviews, several experienced teachers reported time and experience using technology in their classes had increased their comfort level. Rebecca emphasized that if she had the opportunity to lead her peers again, she would encourage teachers to observe lessons modeled in classrooms. Although it was difficult to implement this strategy among teachers who shared planning time, the technology coordinator led lessons for teachers in the computer laboratory upon their request. However, the approach did not contribute to coaching and giving feedback outside of the laboratory setting

Teachers also prioritized tasks to increase comfort. They avoided technology issues at the shared meeting time when other topics required immediate attention. For example, the teachers were asked by administration to implement a skills-based program starting the day after receiving the instructional support materials. Instead of facilitating a discussion about technology issues in the planning meeting, most of the time was spent reviewing the procedures of the skills-based program. Similarly, at the planning meeting on September 10, teachers sought and gave advice on how to handle students' questions about the tragedy of September 11 from the year before. Individual priorities also influenced group discussions. One time Bertha misplaced the lesson she planned to use in the computer laboratory the next day, and used the meeting trying to locate the lesson instead of participating in the discussion. Ultimately, the meeting was cut short so the teacher-leader could assist Bertha in order to ease her anxiety. The issue of priority reinforced the importance of 'just in time' learning for some teachers. Stephanie noted that shared meetings did not support her needs because she prioritized her tasks; she missed several meetings to address other responsibilities. She was confident knowing that she could assertively obtain skills and advice when needed:

> If I want to do something, then it doesn't (get set aside)…. In fact, yes, I try prioritizing. Ask Tina, I'm bad. If I need help with something, that is more focus. She's like, your always have concerns. I am like, I have questions because

> this is what I want to do, and I want to know how you have done it, and I am not afraid to ask.

The consequence of Stephanie's prioritization, however, was the loss of interest from some teachers who perceived meetings as lacking focus or "going off on too many tangents."

The three main influences promoting or hindering reciprocal interactions were shared meeting time, motives for interaction, and desire to reach comfort and overcome anxiety. Reciprocal interactions were stimulated when the shared time addressed the teachers' pedagogical needs, the motives supported the teachers' affective needs, and the time spent for learning experiences more likely eased comfort than elevated anxiety. Reciprocal interactions were hindered when shared time did not involve teachers' curriculum, the proximal location did not involve affective exchanges, and the heightened anxiety of immediate issues overrode preset agenda.

Interactions

Frequency of interactions. The most frequent interactions involved posing and responding to task-based questions, giving and seeking advice, and sharing ideas. As shown in Figure 3.1 these three categories represented over 70% of the interactions observed during planning meetings.

Insert Figure 3.1 Here

The first category, posing and responding to task-based questions, involved knowledge and skill transfer of technology use across members of the community. The interactions were not necessarily always in the form of a question, nor instigated by the peer-teacher. For example, while a teacher registered for the computer laboratory, Samantha offered unsolicited assistance when she observed the teacher's difficulty when using the computer software. Interactions of this nature were often quick and occurred when the entire group was not engaged in discussion. For example, the teachers arrived at meetings within a five-minute interval, and the meeting did not start until the teacher-leaders accounted for all absent teachers. Consequently, those who arrived early often interacted with a teacher-leader by asking a task-based question. Similar questions arose near the end of the meetings if time permitted as elicited by the teacher-leaders.

Giving and seeking advice also contributed to teachers' learning. Tara noted, "I believe the teachers we have are wonderful! They not only give suggestions and advice, but they take into consideration any suggestions others offer." Unlike posing and responding to task-based questions, these interactions often occurred during planning. For example, while one teacher-leader shared a model lesson with peers, advising on instructional strategies and tactics to avoid potential problems, the other advised about designing lessons or technology-based materials. Teacher-leaders also gave advice when they detected potential problems in planning. Once when Bertha planned to use a web resource in her lesson, and Samantha offered, "My only caution about this website is that the ads are sometimes inappropriate, so we don't want the students to click on them."

Sharing ideas occurred frequently in and outside of planning meetings. In the teacher-leaders' modeling efforts, Rebecca often shared lessons she or other teachers devised. Peer-teachers often shared ideas from resources they investigated on their own time, such as professional journals or lesson plan databases. For example, Roger found an idea in a magazine about writing postcards to describe the westward expansion movement. The group then modified this idea to incorporate web resources for one of their lessons. Additionally, teachers shared ideas by posting student work in the hallway outside of their classrooms. One week Colette displayed students' concept maps of the human body, and soon thereafter some peers inquired about the lesson. During the next planning meeting, teachers in the second planning group discussed Colette's activity, and then later used concept mapping as a basis for learning the software *Inspiration*. Sharing ideas was used to broaden the collective knowledge of the community of practice, to provide teachers with a variety of options to address different learning styles, and to maintain high quality lessons within the culture of the community of practice. Interestingly, although other interactions changed with the teachers' increased use of technology in their lessons, the relative frequency of sharing interactions was consistent over the six-month study.

Changes in interactions over time. Interactions shifted as the study progressed. For example, modeling was observed more frequently during the first month of the study. During the planning meetings, the teacher-leaders provided sample lessons for teachers and explained strategies they use to create technology-enhanced lessons. They wanted to provide good examples of the structure of a lesson, including notes and student worksheets. As the semester progressed, the relative proportion of modeling interactions faded. In fact, the teacher-leaders did not review previous modeling interactions unless requested. None of the teachers asked questions in later group meetings for teacher-leaders to re-model previous skills and strategies, but Samantha shared a lesson plan template to use for their individual lessons later in the semester.

As illustrated in Figure 3.2, giving and seeking advice occurred more often near the beginning of the six months, and gradually faded, with the exception of the meeting before the teachers worked independently.

Insert Figure 3.2 here

While teachers focused on modeling during the first month, the teacher-leaders and some of their peers gave advice based on previous classroom lessons. Experienced teachers tended to interject additional advice, especially the grade level chair Roger, to broaden the common understanding across the group. Then, as teachers used some of the lessons in their classrooms, they sought advice about instructional strategies, classroom management issues, and forming curriculum connections. Teachers sought less advice through the developmental phase as they attained common understanding through collaborative design activities. This pattern reversed, however, when peer teachers assumed responsibility to design their own lessons in the proficient phase. At that time, the teacher-leaders facilitated question asking during planning meeting as a means of promoting reflection, giving feedback, and obtaining advice. Hence, the teacher-leaders organization of their peers' learning environment stimulated the giving and seeking of advice.

Posing and responding to task-based questions gradually decreased over the six-month period as teachers became more comfortable with the technology and their tasks. Stephanie noted that "the more I knew, the less I needed someone to sit down and go over it …. Based on what I have learned, I could take it from there." This theme was also consistent with policies and procedures associated with using the computer laboratories. Since more than half of the teachers were new to the school, a high proportion of procedural-based questions were posed near the beginning of the school year. As these lower-order questions were resolved, teachers had more time to engage in more cognitively-rich interactions, such as brainstorming. Some teachers, however, showed continual interest in learning new tools or acquiring new skills, asking task-based questions for direction.

The planning meetings involved extended brainstorming until the teachers worked more independently on their lessons. Teachers were unaccustomed to collaborative brainstorming, but many embraced its potential. In her pre-interview, Michelle reported "I can't say we do much formal brainstorming, but I would if given the opportunity." There was little brainstorming in the first month as teacher-leaders modeled lessons and strategies. Gradually, brainstorming emerged across the community of practice when teachers were *less* interested in the student product of the shared lessons. For example, Bertha and Colette developed alternative ideas when they considered an idea from the first planning meeting to be ineffective for their students. During brainstorming, the peer teachers and teacher-leaders collectively developed possible lesson ideas and sometimes gathered more ideas from other resources, such as previously used lesson plans or web-based lesson databases. The peer teacher then decided which idea would most appeal to his or her students.

During the developmental phase, the nature and frequency of brainstorming accelerated as teachers became more responsible for designing lessons collaboratively. During the first eight weeks of the study, brainstorming consisted of less than 5% of the interactions, but roughly 25% of the interactions once peers mutually created lessons. In addition to developing ideas as they had previously, teachers brainstormed more deeply by examining different instructional strategies, assessment strategies, instructional resources, and curriculum connections. These techniques, however, diminished to less than 5% of the interactions again once teachers became more autonomous in their lesson plan design at the proficient phase. Hence, brainstorming had heightened intensity when mutual responsibility was incorporated in the teachers' design of technology-enhanced lessons.

Teacher-leaders provided additional positive encouragement as teachers became more independently accountable to produce a lesson. During group discussions, peer teachers and teacher-leaders exchanged positive reinforcement when another teacher presented a good idea during the planning meeting. Teachers used phrases such as "great idea!", "awesome job!", "that's really cool!", and gave applause. The positive reinforcement increased interest in some teachers, like Tara, in creating more lessons: "To know that something works, and that you did it, and that you get recognition for it, it's a good feeling…. If I got encouragement, I saw it motivating me to create more lessons." When individual teachers shared an idea with Samantha, she sent an email to the entire community of practice indicating that others might want to consider. Thus, the encouragement was used by teacher-leaders to increase peers' confidence in completing the task and to remind them to maintain their development timeframe. The teacher-leaders provided constructive feedback to help peers improve their lessons, but not at the expense of their participation. When Tabitha doubted completing her lessons, Samantha told her, "There's no part of the credit for this seminar that mentions the quality of your work. No one will say, this lesson is not worthy…don't worry, you are doing ok."

Hence, teacher-leaders used reinforcement to motivate teachers when they faced self-doubt in their capacity to produce lessons.

A variety of reciprocal interactions support technology integration. Sharing ideas, giving and seeking advice, and posing and responding to task-based questions were predominant interactions in the teaching community of practice as teachers learned to design, develop, and implement technology-enhanced lessons. The nature of interactions, however, changed according to familiarity with integrating technology and level of collaboration. As teachers became more experienced in using technology in their classrooms, the amount of modeling, giving and seeking advice, and posing and responding to task-based questions declined. Brainstorming occurred more frequently when teachers were asked to collaborate on lessons, and reinforcing was used by teacher-leaders when teachers needed to become more autonomous and creative in their lesson plan creation.

Discussion

The strength of the community of practice was critical to the implementation of Collaborative Apprenticeship. Wenger (1998) suggested that communities of practice have joint enterprise, shared repertoire, and mutual engagement. In this teaching community of practice, these elements were present, but not necessarily cohesive, throughout the professional development process. For example, teachers expressed interest in pursuing a common goal through joint enterprise, but individual and everyday concerns, such as lack of time, restricted that commitment for some. Lack of time to address instructional issues and develop curriculum are consistently identified as barriers to teacher learning (Lohman, 2000; Zahorik, 1997). In addition, some teachers wanted a greater voice in the group activities. Except for one occasion, the teacher-leaders determined the agenda for group meetings. However, some teachers wanted the effort to stem from the participants, with teachers asked in advance for topics relevant to their needs. Peer-teachers attention to their individual needs also inhibited joint enterprise. Several peer-teachers did not contribute to planning meeting discussions when the curriculum focus, instructional strategies, or use of technology did not correspond with their individual beliefs or classroom activities.

The second element, shared repertoire, was present to a certain degree because the teachers were engaged in similar tasks and responsibilities. They also used the same language when reflecting on their district standards and computer terminology. However, shared repertoire was jeopardized when differences in subjects taught by teachers created a dichotomy of interest at planning meetings. In addition, one of the teacher-leaders was also the technology coordinator, and not an immediate member of the teaching community. She reported she sometimes feeling disconnected from the group, and hoped another grade level teacher would assume mentoring responsibilities. In her journal, Samantha described two other potential mentors that left the community recently, stating, "They were strong leaders and would have been great technology mentors. Having three strong mentors on this grade level would have resulted in more one-on-one support and generation of more samples and examples." In essence, she believed the collegial relationships among teacher-leader and peer-teacher affected the progress of teachers' learning, a perspective consistent with McArthur et al's (1995) findings on peer mentoring research in learning technology.

Mutual engagement was present on occasion in the community of practice. Teacher-leaders were conscious to avoid being perceived as “superior,” preferring to be regarded as a peer—with whom teachers felt comfortable seeking advice. The teacher-leaders were also involved with their peers in lesson planning during the development phase of Collaborative Apprenticeship. However, not all teachers were involved in collaborative planning, even when they were assigned a specific role. For instance, Tabitha reported she could not contribute much to the shared group assignments due to her inexperience, indicating that sometimes she was not given avenues to participate even peripherally. Thus, the group showed many elements of a community of practice through Collaborative Apprenticeship, but pragmatic conditions of the environment limited these characteristics, thus affecting some teachers’ professional growth. In contrast, Hunter (2001), found teachers were capable of overcoming environmental limitations when they were committed to a common goal.

Researcher presence affected the progression of Collaborative Apprenticeship because teacher activities changed sometimes. Ideally, Collaborative Apprenticeship could be implemented without researcher presence or intervention to test its self-sustainability. However, some instances occurred that suggest the model may not have been implemented well without the researcher's participation. As a participant-observer, the researcher primarily observed planning meetings without interacting with the teachers, and met with teacher-leaders in a few reflective sessions. On one occasion, the researcher was seven minutes late to observe a planning meeting. Although he did not have a role in the activities, the teacher-leaders cancelled the meeting. One teacher-leader indicated that the meeting was cancelled because the teachers needed to catch up on their work. The other later reported that the meeting would have likely been shortened, but not cancelled, if the researcher were on time.

Even though the teacher-leaders “owned” the project goals project and directed their peers, they were not involved in designing the Collaborative Apprenticeship model. Perhaps systemic participation in creating the framework might have motivated the teacher-leaders to convene the planned meeting without the researcher's presence. However, professional learning may be more related to establishing priorities rather than overcoming obstacles. One teacher reported: "other people had to make a commitment and offer to do things and create things as part of the involvement in the group. They need to take responsibility for their learning and development if you want this to work." The three peer-teachers' departure from the study when they were held accountable for their productivity was another indicator that reinforces the relationship between individual teacher commitment and joint enterprise.

In addition to presence at the planning meetings, the researcher intervened with teacher-leaders when the planning sessions had not evolved as intended. For example, during the introduction phase of Collaborative Apprenticeship, the teacher-leaders modeled lessons and shared activities for eight weeks when they originally anticipated only three weeks for this phase. Although schedule flexibility allowed more time to extend phases of the apprenticeship, several teachers became interested in creating their own activities. Once the researcher met with teacher-leaders and asked them to reflect on their progress, teacher-leaders realized they had to develop different activities during the planning sessions, like collaborative planning, to reach their goals. Consequently, without the researcher's presence and occasional intervention, it is unclear how or if teachers would have progressed in their technology integration efforts.

The findings suggest that teachers need an environment that ensures comfort, or strategies to ease discomfort, for learning. With the exception of high achieving teachers, peer-teachers underscored the importance of comfort with their environment, peers, and technologies when learning for instructional purposes. Some new teachers felt distracted due to the need to acclimate to the school. With so many other responsibilities, learning to use technology was a secondary priority for some teachers. One stated that she did not feel safe in the environment initially until she developed relationships with some of the other teachers because she arrived from a different culture on an exchange program. "Connecting" was important because it established the comfort needed to share ideas and resolve classroom challenges. This is consistent with Hertzog's (2002) research indicating that novice teachers often consult with peers other than their mentors primarily based on their interpersonal relationship rather than their experience. Teachers who were comfortable in the sessions considered them a great environment to tell stories and gather ideas; those that did not tended to share outside of the meetings and considered the meetings to be unproductive.

Another aspect of comfort relates to teachers' familiarity with the technology tools. Many teachers stated that they needed to feel confident with a tool before using it with a class, often to troubleshoot students' questions. Near the end of the study, Samantha introduced teachers to *Math Keys*, software with mathematical manipulatives. She told the teachers that a goal was to develop a lesson using this software since the fifth grade curriculum did not have many technology-enhanced lessons in mathematics.

However, only one teacher actually incorporated the software in her independent lesson. When asked about using the software in their classrooms, some of the teachers explained that they were interested but were not yet comfortable with their understanding of the software. Hence, teachers need to feel comfortable with the environment, the people, and the resources in order to optimize the use of technology in their classrooms.

Implications for Research and Practice

Several issues have emerged related to Collaborative Apprenticeship, such as long-term effects and impact of the model, the strength of the community of practice, examination of different factors, the facilitation of shared time by teacher-leaders, mentoring strategies of teacher-leaders, and the comfort level for peer learning.

Longitudinal analysis and impact. The six-month study detailed how teachers learn to use technology and to support each other during three phases of the Collaborative Apprenticeship, but not mastery phase. In the mastery phase, peer-teachers assume the position of teacher-leaders who support the development of their peers, essential to the long-term sustainability of the approach. To wit, one teacher-leader reflected on the importance of using Collaborative Apprenticeship over time, noting “I think it would be one of those things that you would want to implement at the very beginning of the year, and do it all year long, and then keep it in place for a couple of years.” As a new approach, it is essential to validate the assumptions underlying the model. Further research needs to examine how the community’s leadership and technology integration practices evolve, paying close attention to factors that enable the transition and sustainability of leadership and mentoring. Moreover, we need to examine how student learning influences teachers' commitment to the community's goals, since teacher effort is often guided by students' enthusiasm and performance (Franke, Carpenter, Levi, & Fennema, 2001). Research of this nature requires an examination of actual classroom teaching, student learning, instructional materials, and student assessment.

Strength of the community of practice. Although, in the past, the school exhibited attributes of a community of practice, the large percentage of new teachers affected its collegiality. Over time, the teachers developed personal relationships, but the dramatic change in the community affected the potential for richer interactions. Hence, researchers should examine interactions across a community of teachers that has developed a strong connection, personally and professionally, as well as the feasibility of the model to build stronger relationships among teachers less developed communities of practice. Further research should also investigate how implementation of the model influences personality factors, such as motivation, responsibility, and organization.

Facilitation of shared time. The common planning periods used to model activities, share ideas, and give advice were semi-structured by the teacher-leaders. The teacher-leaders could facilitate the shared time in whatever form deemed appropriate, while being cognizant of the teachers' development and needs. However, some teachers reported that the organization of time and structure of discussions did not support their learning needs. Consequently, teacher-leaders need to find strategies to closely examine their peers' learning needs, such as regular reflection sessions, in order to comprehend how shared time can be used effectively across the community of practice.

Promoting comfort. Teachers interact and learn best in situations where they feel most comfortable. They do not need to be successful in order to feel comfortable; rather, teachers need support and encouragement to take risks so they can share and learn from their mistakes. Teachers feel comfortable discussing difficult issues with a trusting colleague who listens and addresses issues in a supportive way. They feel comfortable in settings when they are not unduly pressured by time constraints, and are able to learn the features and capabilities of a technology tool before using it in a lesson. If teachers do not feel comfortable in these ways, then many are less likely to interact and learn from their peers. Consequently, we need to examine school structures that promote comfort in the schools, whether by pairing teachers with similar personalities, giving more time to learn, reducing responsibilities, or providing additional opportunities to learn to use technology.

Limitations

The methods and measures used in this research have several limitations. First, data collection was undertaken during scheduled meetings, failing to account for the more continuous interactions before, during, or after school. Consequently, informal interactions were limited to the teachers' reports in interviews, in their reflection statements, and occasionally in email exchanges between teacher-leaders and peer teachers. Second, the data cannot clearly delineate which interactions and factors are influenced by the presence of the Collaborative Apprenticeship per se since many interactions likely occurred outside of planned meetings. Third, distinctions were not formed between interactions and reciprocal interactions because Collaborative Apprenticeship as a framework assumes that participation involves an ongoing willingness to support and learn from peers. However, individuals sought assistance and advice in few instances without the intent to contribute to the learner's understanding.

The findings are limited by several factors. First, although the research is bounded by a single case and thus has limited generalizability, the factors and interactions may inform organization and practice within other communities of practice. Next, the quality of the lessons generated by peer teachers and their impact on student learning was not analyzed because the emphasis was on the interactions among teachers and the factors that influence those interactions. Third, the coding framework potentially limited the analysis since the approach did not use the actual language of the participants. However, constant comparative analysis techniques addressed this limitation through ongoing assertions and continual revision until data saturation, the moment at which additional data was not altering the findings. Finally, the impact of the model and its influence on reciprocal interactions is not clearly delineated from naturalistic practices in a professional community of practice. Although certain interactions were promoted with Collaborative Apprenticeship, such as brainstorming, the findings cannot determine how many more interactions occurred as a result of using this model. Further, the findings cannot suggest whether Collaborative Apprenticeship stimulates various factors, such as motivation, that influence reciprocal interactions.

Conclusion

A variety of factors influence reciprocal interactions. The intent of using Collaborative Apprenticeship was to provide teachers learning experiences across a community of practice that were onsite, ongoing, and just in time. Although the entire community of practice had these opportunities, roughly one-third of the teachers were proficient at the end of a six-month study. All teachers expanded their knowledge, skills, ideas, and lesson plan repertoire, however, through their learning experiences. In essence, the collective activities of the community of practice promoted new professional opportunities for the individual, and the lessons created by the individuals expanded the resources and possibilities within the community of practice.

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Table 3.1

Participant[5] Profiles

Teacher	Years at School	Planning Group	Role	Entry Level	Completion Level	Factors and Interactions That Supported Development	Factors and Interactions Hampering Development
Samantha	8	1st and 2nd	Teacher-Leader	Mastery	Mastery	giving advice, human resources, respect	reflection, connection to group, connection to individual
Rebecca	4	1st	Teacher-Leader	Mastery	Mastery	connection to individual	proximity, reflection
Michelle	3	1st	Peer-Teacher	Developmental	Reached Proficiency	shared time, sharing ideas	accessibility
Roger[6]	3	1st	Peer-Teacher[7]	Ready for Mastery	Ready for Mastery	connection to individual, curriculum	individual time
Tabitha[6]	0	1st	Peer-Teacher	Introduction	Introduction	connection to individual, caring	lower-order thinking, connection to group, shared tasks
Stephanie[6]	0	1st	Peer-Teacher	Introduction	Reached Developmental	connection to individual, human resources	priority, accessibility, learning beliefs
Deborah	0	1st	Peer-Teacher	Introduction	Reached Developmental	connection to individual, open-mindedness	shared time, priority, organization
Tara	0	1st	Peer-Teacher	Introduction	Ready for Mastery	positive reinforcement, sharing ideas, human resources	learning beliefs
Chandra	0	1st	Peer-Teacher	Introduction	Introduction	human resources, connection to individual	individual time, teaching beliefs, connection to group
Bertha	2	2nd	Peer-Teacher	Introduction	Reached Proficiency	responsibility, human resources, social obligation	physical resources, priority
Colette	0	2nd	Peer-Teacher	Introduction	Ready for Mastery	physical resources, human resources, assertiveness	connection to group

[5] Pseudonyms were assigned to participants to protect their confidentiality.
[6] Discontinued participation in study after 15 weeks.
[7] Also served as the grade-level chairperson.

Table 3.2

Teachers' Contributions to Development of Technology-Enhanced Activities

Number of Weeks	Technology Integration Phase	Teacher-leader Roles	Peer-teacher Roles	Collaborative Partnership	Activities Completed
Eight	Introduction	Promotes and models use of technology in workshop or classroom environments	Observes and participates in learning applications of technology	Discuss and reflect on learning and design experience	Three
Seven	Developmental	Provides scaffolding, coaching and fading to design, develop, and implement learning activities	Acquires software and design skills in context of participation	Collaboratively design, develop, and implement technology-enhanced learning activities	Three
Eight	Proficient	Identifies areas for improvement and exploration	Articulates understanding by autonomously designing activities	Share experience and ideas with peer community	Two
Not completed in study	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	NA

Table 3.3

Example of Organization Chart of Coded Data

Element	Type	Example(s)	Data Example
Reciprocal Interactions	Story Telling	classroom experiences, student actions, teachable moments	During an observation, Sarah gives examples of how students have been making mistakes and losing their work.
	Backscratching	task completion	Andrea mentioned in her post-interview that teachers create instructional materials and make photo copies for one another.
	Discussing and resolving conflict	student behavior problems, instructional challenges, resource access	Teachers address problems with students' attention span during a meeting. They offer strategies to minimize students' hyperactivity.
	Brainstorming	soliciting ideas, devising lessons collaboratively	The group devises a set of possible student products for the next lesson they will plan together.
	Giving/seeking advice	student learning needs, curriculum connections, instructional strategies	Samantha suggests to Bertha that she use a different website for her lesson to avoid advertisements.
	Modeling	teaching lessons, talking about design strategies, demonstrating software	Rebecca and Samantha explain to the teachers the various components involved in a technology-enhanced lesson.
	Sharing ideas	lessons, instructional resources, web sites	Roger shows a lesson idea he found in a teaching magazine.
	Motivating	verbal encouragement, physical expression	Roger applauds Tabitha when she brought her students to the computer lab.
	Posing/responding to questions	computer skills, procedures, information	Tara asks Samantha how to sign up for lab time if students are doing research on the Internet.

Table 3.3 (cont)

Element	Type	Example(s)	Data Example
Factors	Affect	caring, anxiety level, patience and sensitivity, enjoyment, connection to group, friendly climate, connection to individual, respect	Tabitha reported in her postinterview that she appreciated Colette's friendship based on their common interests.
	Beliefs	teaching, learning, instructional design, social obligation, self-efficacy	Bertha needed to explain the social studies curriculum to her peers because others have helped her in the past
	Environment	proximity, shared time, individual time, human resources, physical resources, accessibility	Tara sought support from Roger and Chandra because they were experienced teachers next to her classroom.
	Culture	leadership, professionalism, curriculum, mutual responsibility, peer feedback, shared tasks	Samantha told Colette that she could improve her web pages by adding a few more links in case some of the resources are not accessible when students need them.
	Cognition	common understanding, priority, awareness of learning behaviors, lower order thinking, higher order thinking, reflection	In his preinterview, Roger explained that it was tricky to teach teachers because some like to play on their own and some like to be guided so they don't make mistakes.
	Personality	assertiveness, motivation, responsibility, autonomy, availability, open-mindedness, organization	Samantha reminded the teachers that they could ask questions and obtain assistance any time during the day just by making an appointment.

Adapted from Glazer & Hannafin (2003)

Table 3.4

Overview of Findings

Major Finding	*Secondary Finding*	*Examples*
Planning meetings during the school day	i. new opportunities ii. access to experts iii. sometimes counterproductive iv. teaching beliefs v. isolation	i. sharing and brainstorming ideas ii. suggestions from teacher-leader iii. sidetracked discussions; difficult to concentrate iv. sample lessons plans use different teaching philosophy v. difficult to interact across groups; assertiveness necessary
Motives	i. curriculum ii. connection to individual iii. expertise iv. physical proximity as secondary factor	i. share ideas with those who teach the same classes ii. share stories, seek assistance, discuss problems, similar experience iii. supporting technical and instructional needs, non-technology issues iv. select nearby teachers when other factors are considered
Anxiety and comfort level	i. implementation ii. more experiences iii. participation iv. prioritize tasks	i. potential problems in classroom; observing lesson ii. collaborative planning; model lessons iii. commitment; time away from other responsibilities iv. other tasks during meetings; not attending meetings
Frequency of interactions	i. posing and responding to task-based questions ii. giving and seeking advice iii. sharing ideas	i. knowledge and skill questions; when and how they are asked ii. why and when they are asked; expert influence iii. past lessons, external resources, hallway display, crediting others' work
Changes in interactions over time	i. modeling near beginning ii. giving and seeking advice near beginning iii. posing and responding to task-based questions near beginning iv. brainstorming near middle and end v. increase in positive encouragement	i. sample lessons, fading ii. not just from leaders, connection to common understanding and responsibility, teacher-leaders' organization of planning iii. knowledge and skills, beginning teachers, different for advanced teachers iv. not interested in sample lessons, collective planning v. individual accountability, promote confidence

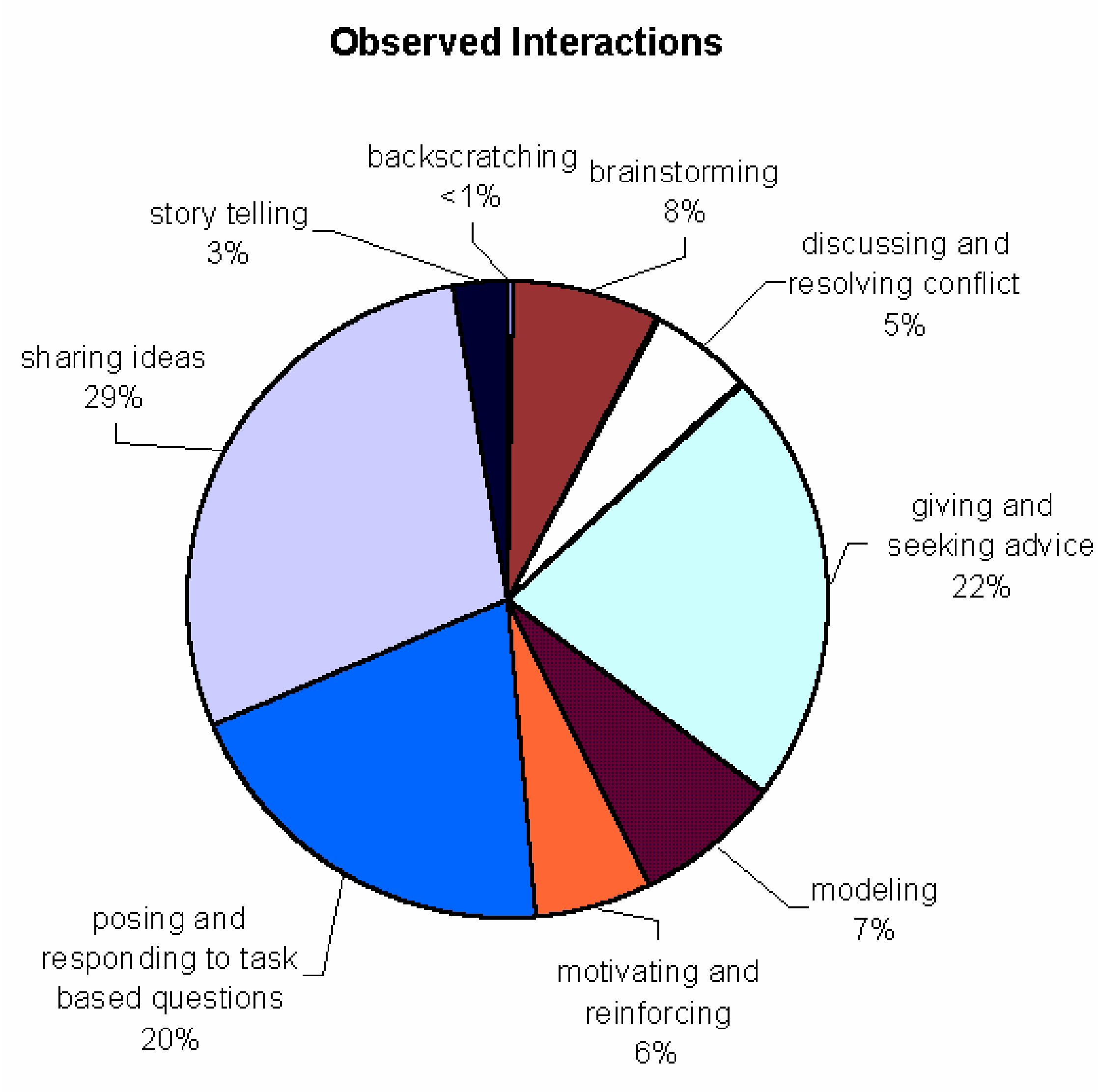

Figure 3.1. The distribution of 403 observed interactions in 15 planning sessions.

Figure 3.2. The relative frequency of interactions that involved giving and seeking advice by month.

CHAPTER 4

FACTORS AND INTERACTIONS THAT INFLUENCE TEACHERS' GROWTH DURING TECHNOLOGY INTEGRATION PROFESSIONAL DEVELOPMENT[8]

[8] Glazer, E. M., & Hannafin, M. J. To be submitted to *Technology and Teacher Education*.

Abstract

This study examined the factors and interactions that support teachers' mentoring and development as teacher-leaders supported peer efforts to integrate technology using a Collaborative Apprenticeship framework. Results indicate that teachers who were more successful in designing technology-enhanced lessons tended to interact differently from their peers. Rapidly developing teachers assumed more ownership in their learning and consequently interacted more frequently to obtain support and advance their development. Further, when their primary motivation was to develop strategies to improve student learning, successful teachers overcame learning obstacles. Peer mentoring techniques also influenced the interactions and quality of teacher growth in the community. In general, mentors resisted interactions perceived as potentially jeopardizing collegial and interpersonal relationships, even when peers did not demonstrate growth in their learning.

Factors and Interactions that Influence Teachers' Growth During Technology Integration Professional Development

Technology integration efforts in K-12 schools face many obstacles. Lack of human and physical support, insufficient learning opportunities, and reluctance to change instructional practices has prompted resistance to technology use in schools (Cafolla & Knee, 1995). Even when professional learning opportunities are provided in the form of staff development workshops, many teachers believe the activities will not transfer well to classroom practices (Marcinkiewicz, 1991). Rather than after school or summer workshops, teachers need opportunities to learn and apply strategies within their school environments because learning is fundamentally situated (Lave & Wenger, 1990). They also need access to human support that is onsite, just in time, and ongoing (Byrom, 1998). Providing such support can be demanding, especially when schools commit much of their technology budgets to hardware upgrades and maintenance (Ronnkvist, Dexter, & Anderson, 2000). Therefore, we need to examine how existing human and physical resources within a peer community can be utilized to sustain technology integration.

Taking responsibility for professional learning demands strong commitment to thinking as and participating in a "community of practice" (Wenger, 1998). Shared repertoire, mutual engagement, and joint enterprise are critical to promoting mutual dependence and sustainable support. Teaching communities of practice form a collective vision, participate in shared practices, and formulate meaning through social negotiation, brainstorming, troubleshooting, and advice giving. Ongoing, constructive interactions designed to encourage collaboration among community members are fundamental to these practices. Reciprocal interactions encourage collegial relationships that help to build strong, sustainable support networks and promote ongoing learning opportunities (Glazer & Hannafin, 2003a), indicating a mutual partnership among individuals contributing to a shared community vision. Partnerships, consequently, are essential for building professional capacity and strengthening the community of practice.

Reciprocal interactions also influence collaborative partnerships needed to sustain technology integration efforts. Several staff development (e.g., Browne & Ritchie, 1991) and mentoring (e.g., Holahan, Jurkat, & Friedman, 2000) models have highlighted the positive influence of collaborations and interactions when integrating technology in K-12 schools. MacArthur et al. (1995) reported that mentoring relationships had a positive impact on teachers' efforts to learn and use technology tools within their classroom. They described relationships between mentor and protégé as "the heart of the entire mentoring process" (p. 52). While their multi-school research provided rich detail about factors affecting peer partnerships, the study did not examine the impact on the professional growth among the teachers' community of practice. That is, it is not clear how individual partnerships affect sustainable professional learning across a group of peers teaching similar courses using the same technology tools. Thus, it is valuable to examine elements of mentoring relationships that support the community of practice's growth in order to sustain technology integration efforts in school contexts.

The purpose of this study was to identify critical factors and interactions that support teachers' development when using a Collaborative Apprenticeship model for technology integration. The research questions included:

- How might interactions and factors relate to the growth of teachers as they incorporate technology into their instructional practices?

An additional question emerged in the data collection process to address the role of mentoring in the technology integration process:

- How might factors and interactions between the teacher-leaders and peer-teachers affect the professional development of peer-teachers?

Framework

Successful mentoring requires ongoing communication and interaction between mentor and apprentice. Among peers, collaboration is a mechanism by which skills and strategies can be modeled by teacher-leaders and developed by peer-teachers. Teams of teachers become mutually engaged (Wenger, 1998) in designing learning activities and supporting each other's learning by reciprocally interacting. Reciprocal interactions "demonstrate and influence a mutual relationship that supports learning and development" (Glazer & Hannafin, 2003a).

This study examined factors contributing to professional growth and mentoring relationships of teachers as they strove to integrate technology into their instructional practices. A community of fifth grade teachers established mentoring relationships using the Collaborative Apprenticeship model for technology integration (see Glazer & Hannafin, 2003b, for description and Appendix B for timeline) to scaffold peer-teacher learning. The Collaborative Apprenticeship model promotes mentoring relationships that involve gradual acquisition of tool knowledge and design strategies, incorporating onsite, ongoing, and just-in-time support as teachers learn to create technology-enhanced materials for their classrooms. In this effort, teachers developed strategies to enhance student learning opportunities using technology-enhanced lessons. In the process, they considered available resources, curriculum connections, instructional strategies, and learning theories.

Method

Participants and Setting

A community of teachers was purposefully selected to participate from a K-5 elementary school located in a suburban community in the southern United States. The school, enrolling approximately 1400 students, was chosen because mentoring was already ongoing. The school's peer mentoring program featured experienced teachers supporting new teachers as they became familiar with and adapted to school policies, procedures, and culture. The philosophy of mentoring in the school was similar to the roles in Collaborative Apprenticeship, where collective partnerships involve a combination of learning skills and strategies, developing relationships, and supporting individual needs (Hertzog, 2002). The school was also selected because most teaches at the same grade level had opportunities to collaboratively share and develop activities during a common 45-minute daily planning period. The fifth grade level was chosen because it incorporated important elements of a community of practice, namely joint enterprise for having common goals, shared repertoire based on similar job responsibilities, and mutual engagement through collaborative professional activities. Each member of the community of practice had skills and experiences they could contribute for the group's benefit, including knowledge of curriculum, student discipline strategies, technology tools, and nature of the school environment. Hence, the community of practice was asked to expand slightly its mentoring and shared planning practices in order to invest in teachers learning of technology integration strategies from their more experienced peers.

As a result of new leadership and opportunities in the school district, the teaching community experienced personnel changes prior to the study. The 5th grade level lost many of its experienced technology-users, with 6 of the 11 teachers new to the community. Among these, 10 teachers agreed to participate in the Collaborative Apprenticeship for technology integration.

Participants included two teacher-leaders and nine peer-teachers. Participant role and teaching experience is listed in Table 4.1. Each teacher-leader had demonstrated leadership in using technology in classrooms, mentored peers in their school previously, as well as interest in orchestrating their peers' development. In addition, prior to the study, the researcher[9] facilitated a reflective discussion for peer-teachers to generate their own mentoring strategies effective for their teachers' environment, including how and when to provide support, how to maintain interest, and how to respond to teachers' learning needs. The researcher assumed these traits and experiences prepared the teacher-leaders for coordinating the development of their peers in this study. Teacher-leaders Rebecca and Samantha developed their expertise through participation in 40-hour technology-training workshops. They were expected to support teachers subsequent to the workshop, but had been unable to deliver successful strategies for systemic integration across the community of practice. Samantha facilitated a 40-hour technology workshop to teachers at her school as an attempt to increase computer use across the school, but noticed workshop participants did not support their peers' use of technology at their respective grade levels. After presenting this challenge in a graduate course, the researcher offered to coordinate the implementation of a different strategy for technology integration, Collaborative Apprenticeship, with a grade level that embodied characteristics of a community of practice. Consequently, a partnership was formed between the researcher and community of fifth grade teachers embodying the teacher-leaders and peer-teachers of the study. Peer-teachers, the novice participants, were selected by the teacher-leaders. They had few technology skills, did not complete the technology training workshop, and had little experience designing technology-enhanced lessons; however, each expressed interest in learning to use technology effectively in their classrooms.

Insert Table 4.1 Here

Prior to the study, technology had been used in this community of practice, but not to support students' thinking. Whereas peer-teachers brought their classes to the computer laboratory to practice skills or play educational games, the teacher-leaders sought creative and reflective technology uses that tied activities to higher-ordered thinking and curriculum. Since expectations were raised as to the quality and creativity of technology-enhanced lessons, participating teachers received 2-3 staff development units.

In this study, the researcher was a participant-observer. Although involvement with teachers was primarily through non-obtrusive observations, mere physical presence sometimes influenced participation. In addition, the researcher introduced the Collaborative Apprenticeship to teacher-leaders, responded informally to specific conflicts, stimulated reflection among teachers in their journal writing, and met with teacher-leaders occasionally to discuss progress. Teacher-leader meetings were initiated when the group activities were judged to be ineffective, during which the researcher

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[9] The researcher is the first author of this paper.

prompted the teacher-leaders to reflect on their own strategies for scaffolding peer-teachers' learning based on the conditions within their environment.

Research Design

Qualitative methods were used because the research focused on revealing how learning and development were supported rather than testing a theory or comparing treatments. A case study approach was used because the phenomena were bounded by a technology integration effort within a teaching community.

Data Sources

Interviews, observational field notes, and reflective journals were data sources in this study (see Appendices in Glazer, 2003, for protocol used in study; see Appendix C for alignment of each data source and its corresponding research questions). A pre-interview was conducted prior to the study to determine how technology was used in teaching and how participants supported each other's learning (see Appendix D); this information was shared with teacher-leaders with participant permission. Once the study began, informal interviews (see Appendix E) were held to document concerns and clarify as needed. Similarly, reflective sessions (see Appendix F) were convened with teacher-leaders to devise strategies for empowering peer teachers. A post-interview (see Appendix G) was conducted after the study to examine technology use, critical factors and interactions that supported teachers' growth, and planned future uses of technology and participant mentoring.

Observational field notes documented reciprocal interactions during planning meetings and informal encounters. The weekly observations addressed issues central to support teachers' learning to integrate technology effectively into classroom practices. In addition to field notes, an ongoing journal was maintained to document reflections on field experiences and teacher-leader meetings, and posit tentative assertions based on recurring themes.

Reflection statements were also collected to establish teachers' perceptions of their own, as well as their peers', growth. Peer-teachers responded to questions about their likes, dislikes, interactions, and growth (see Appendix H). Teacher-leaders maintained a bi-weekly journal (see Appendix I) that documented teachers' progress, collaboration, and interactions used to support their peers' development.

Efforts were made to strengthen credibility and trustworthiness of the data. Field notes were expanded within one day of the field experience to elaborate observations in a timely manner. In addition, the researcher's journal documented critical events, courses of action, assertions, and general reflections. An audit trail was also maintained to record the chronology of data collection and analysis (See Appendix J). To minimize possible myopic and idiosyncratic coding and data reduction, a research team comprising 6 doctoral students in Instructional Technology validated the initial codes, worked collaboratively to reconcile disagreements, and proposed alternative codes as needed. Data were collected over a six-month time period, allowing opportunities to continually revise assertions. Further, triangulation was undertaken (Glesne & Peshkin, 1992) providing multiple data sources to reinforce assertions.

Procedures

Prior to the study, the researcher and teacher-leaders discussed the different phases of Collaborative Apprenticeship, and jointly developed mentoring and instructional design strategies based on their collective experiences and understanding of the teaching community of practice. At the request of the teacher-leaders, the pre-interview was administered during the first three weeks of the study, one month later than anticipated (see Appendix J for timeline), to give new teachers an opportunity to become acquainted with the school culture and their responsibilities.

One experienced fifth-grade teacher and the school's technology coordinator mentored teachers in two different learning groups. Since it was not possible to schedule a shared time for all fifth-grade teachers, one group consisted of two-teacher leaders and seven peer-teachers, and the other group involved one teacher-leader and two peer-teachers. The technology coordinator acted as teacher-leader for both groups, relaying activities between groups to promote communication across the entire grade level.

During planning sessions, teachers discussed possible lessons, reflected on the curriculum, incorporated instructional strategies, addressed problem posing and design issues, and demonstrated technology uses to stimulate thinking. The frequency and duration of planning meetings was gradually reduced during the study according to teachers' learning needs and progress. In addition, many teachers met informally to obtain individual feedback, brainstorm ideas, and explore different tools.

Peer-teachers were asked to implement a minimum of eight technology-rich lessons over six-months. The initial activities were modeled in planning sessions, and subsequently teachers produced at least three original lesson ideas collaboratively and independently. Peer-teacher productivity varied as teacher-leaders attempted to draw on the strengths of the more successful teachers to promote the development of their peers. Six of the nine participating peer-teachers ultimately implemented the minimum number of activities; time demands and lack of knowledge and skills hindered the full participation of the other three teachers. Their participation declined during the proficient phase of Collaborative Apprenticeship as they were asked to take more responsibility in the design of original activities.

During planning meetings, teacher-leaders focused on using technology as a cognitive tool to support learning rather than learn from technology (Jonassen & Reeves, 1996). Initially, they focused on using the Internet to gather information to make an argument, create a story, or develop a product. As time progressed, they introduced other learning tools, such as *Inspiration* for writing and *Math Keys* for mathematics, modeling how tools were used in lessons, as well as strategies to create new lessons. Teachers either continued using a particular tool in multiple ways, or explored other tools in different areas.

Once teachers were confident in their instructional uses of a tool, teacher-leaders encouraged them to develop original ideas and different technology-rich projects to enhance student learning. In support of onsite, ongoing, and "just in time" learning, teacher-leaders served as "more knowledgeable others" (Vygotsky, 1978) by giving advice, feedback, and support when requested. In addition, teacher-leaders recommended that peers support one another in their efforts to promote peer-teachers' self-reliance. The teachers were not encouraged to be independent, but instead to demonstrate competence in their design practices by using acquired strategies and interacting with peers. Teacher-leaders used Collaborative Apprenticeship to orchestrate teachers' peer learning (see Appendix K for a more detailed outline). The teachers' roles and activities in the study during different phases of Collaborative Apprenticeship are presented in Table 4.2.

Insert Table 4.2 here

Introduction phase. During the first eight weeks, the first three activities were shared with peer-teachers during their common planning period. The sample lessons were selected by the teacher-leaders based on personal classroom experience or positive review from an external resource such as a lesson plan database or teacher journal. For example, instructional strategies, lesson ideas, and student worksheets were shared with peer-teachers in a lesson about Westward Expansion, where students created postcard stories using historic information they gathered on the Internet, from the teaching magazine *Mailbox*. During the 45-minute meetings, teacher-leaders modeled the lessons, shared instructional and design strategies, demonstrated technology tools, discussed classroom management, and addressed curriculum integration issues.

Developmental phase. During the following eight weeks, three more activities were designed collaboratively in teams of two or more under the tutelage of the teacher-leaders. For example, one team designed a lesson aimed to organize students' writing using the software *Inspiration*. Teachers created goals collectively, while teacher-leaders developed strategies to support them. Planning meetings focused on brainstorming, examining curriculum and available resources, and collaborating to devise technology-enhanced lessons. Introduction phase activities (e.g., modeling and sharing) remained, but interactions shifted to promote mutual engagement. Initially, teacher-leaders guided by encouraging peer-teachers' participation and modeling the organization of lesson subcomponents and resources. Gradually, teacher-leaders faded their mentoring (Collins, Brown, & Newman, 1989), thus giving peer-teachers more accountability for the design and development of their technology-rich lessons. Halfway through this phase as mentoring required fewer interactions, teachers met less frequently for group planning in order to devote time to their smaller teams. During their design and development experience, teachers wrote in journals to reflect on their classroom implementation (see Appendices G and H) and their readiness to assume greater responsibility for lesson design. The teacher-leaders and researcher reviewed the reflections to determine reasonable expectations for teacher development.

Proficient phase. Each peer-teacher developed two additional independent technology-enhanced activities during the next eight weeks, with progressively less support from teacher-leaders. [Note. The technology coordinator served as the only teacher-leader for the remainder of the study because the other went on a leave of absence for reasons unrelated to the study.] Peer-teachers collaboratively designed the first lesson without teacher-leader guidance. They used shared planning time only once to discuss progress or seek advice from other teachers. As a consequence of a shift in responsibility, the teacher-leader mainly evaluated new lessons or responded to peer-teacher questions. Upon examining the new lessons, the teacher-leader noted how learning supported curriculum standards and how technology afforded opportunities for rich learning experiences. For example, some teachers design mathematics lessons that incorporated numerous standards and investigative thinking using probability simulations or mathematical manipulatives. During the final four weeks of this phase, peer-teachers became independently capable of creating and implementing an original technology-enhanced lesson, which was then shared with the community for future use.

Mastery phase. According to the Collaborative Apprenticeship model, peer-teachers who reach mastery mentor their peers, that is, assume the responsibilities of a teacher-leader. This phase was not addressed in the study's design since participation embodied almost the entire community. At the end of the study, teacher-leaders and peer-teachers were interviewed to assess whether peer teachers were prepared to mentor new teachers entering their community of practice in the future.

Analysis

Coding

Using the Collaborative Apprenticeship factors and interactions, summarized in Table 4.3, we established initial codes to describe the data. Observational field notes, peer-teacher reflections, teacher-leader journals, researcher reflections, and interviews were coded according to the existence (or lack of) these key reciprocal interactions and factors. Criteria for assigning codes were initially determined by the researcher, and later adjusted according to consensus from a research team (see Appendix L for criteria).

Insert Table 4.3 Here

The researcher coded data continuously throughout the study. A six-member doctoral student research team was used to strengthen the credibility of coding assignments and the trustworthiness of the findings, independently coding different data samples, and re-examining code criteria to resolve discrepancies. As needed, the researcher provided additional information from the field experience to provide greater context to support code assignments. In addition, the coding scheme accommodated new entries as data involved different factors and interactions. When a team member posited the presence of a new code, the group re-examined the data to determine whether it offered distinguishable qualities from the existing set. After mutual agreement, the team established a code name and criteria for further identification. The large number of new codes prompted the researcher to re-examine the entire data set upon completion of the study and re-code where appropriate.

Organization

Data were organized into a table related to reciprocal interactions and factors according to data codes. More than 2200 codes were assigned; some data had multiple codes. For example, three codes were identified in the observation: "Deborah dropped off a folder to Sally with resources on immigration before the meeting. She said that the teachers can use any of the resources." First, 'connection to group' was assigned because Deborah was finding a way to share materials across the grade level, even though she belonged to a different planning group. Second, 'physical resources' was identified because the teachers were exchanging lessons and resources used in the past and found on the Internet. Third, the code 'sharing ideas' was noted because the teachers were exchanging resources to be shared with the other group. A spreadsheet was used to organize codes in order to dynamically adjust and represent them throughout the analysis.

A frequency table was also developed to represent the different factors and interactions present according to teachers' level of development. Teacher's level of development reflected the Collaborative Apprenticeship phase associated with the support needed to design technology-enhanced lessons. Each teacher's completion level listed in Table 4.1 was determined by cross-checking the peer-teachers' self-evaluation and teacher-leaders evaluation during the post-interview. Once teachers were clustered according to level of development, interaction frequencies were examined to determine how and if they changed during teacher development, enabling another representation of interaction trends.

Identifying Thematic Patterns

Constant comparative analysis methods (Creswell, 1998; Strauss & Corbin, 1994), involving continual examination of patterns surrounding reciprocal interactions and factors, were used to reveal themes. Assertions were made to reflect similarities and differences among data samples within coded clusters, then refined by adding or refuting information. Ongoing revisions were made to assertions until additional data no longer contributed meaning to the findings. Upon completing the data collection, the research team reviewed the organized data to formulate assertions for all codes, comparing their sets of assertions and clarifying inconsistencies. In such cases, the researcher re-examined data to resolve discrepancies across team members. During the process, more than 200 assertions were developed to reflect the various codes, which were subsequently applied in further analysis (see Appendix M).

The research questions were addressed by grouping smaller assertions and relative frequency patterns appropriate to each initial research question. Broader assertions were made for each research question to address common themes presented in the clusters. After creating broader statements, the smaller assertions and patterns were re-examined. As they became concrete, the preliminary assertions and organizational chart were used to collate information. To validate, we presented the primary findings to the teaching community for a member check; teachers confirmed a majority of the findings. A few questions about teachers' knowledge of resources and support prompted the researcher to review assertions and reformulate their description until agreed by members of the teaching community. For example, participating teachers modified the assertion of teachers not having access to resource materials, such as instructional guides, to not being aware the resource materials were available.

Findings

Participant development, and influential interactions and factors are listed in Table 4.1; findings related to factors and interactions in teacher development and mentoring relationships are summarized in Table 4.4.

Insert Table 4.4 Here

Teacher Growth

As expected in most communities of practice, understanding and skills varied across the community of practice at the beginning of the study. Subsequently, teachers' skills and strategies developed at different rates. By the end of the study, peer teachers attained different levels of development even though teacher-leaders tried to advance all peer-teachers to the proficient phase. Some were ready to assume the role of a mentor, while others lacked basic understanding and skills associated with the introduction phase. In the following section, we examine factors and interactions that affected teacher growth across the community of practice, contrasting teachers who thrived with those who did not.

Factors evident among high achieving teachers. Teachers who developed skills and strategies consistent with the proficiency and mastery phases of the Collaborative Apprenticeship model tended to be motivated, focused on students' learning, took responsibility for their learning, and involved many resources beyond their local community of practice. Motivation was demonstrated in the teachers' desire to succeed professionally. Bertha saw the experience of working closely with a peer-expert as a "window of opportunity". Tara was conscious of her performance, noting "I want to be a good teacher….and I don't want to teach something that is wrong, or teach it the wrong way. Why make things difficult on yourself?" Motivation increased with positive peer feedback. After sharing a lesson with Tina, one peer teacher reflected:

> She emailed me and said, I heard you had a good health unit, can I borrow your stuff? It's word of mouth I guess (laughs). That's good that she is a veteran teacher and she asked me for information. It's nice to get that. It kind of motivates me to keep going. I just feed off of the positive feedback.

High achieving teachers also had less teaching experience, and attributed some of their motivation to being naïve. Colette remarked, "I think a lot of it has to do with it being my first year, and I don't know a lot of what I am doing, so I am motivated to do the best I can." Rebecca speculated newer teachers did not realize the amount of work that will potentially exhaust them in the future.

Although not all laboratory activities were successful, proficient teachers consistently discussed their students' learning. When teachers were asked to describe their experiences and professional development, they often reverted to descriptions of how students learned in the activities they designed. Teachers were pleased with their students' work. Tara noted, "I was very impressed with them…It was nice to see that they were able to guide themselves through the Internet." The teacher-leaders also noted the peer-teachers' interest in their students' learning. During her post-interview, Samantha noted high-achieving teachers were successful because they tried to cultivate a learner-centered classroom. Colette described why a student-centered approach with technology is particularly useful for her teaching: "I think most kids can learn when you use technology because it's fun and motivating to them. The results are pretty. So that motivates me."

Proficient teachers took responsibility for their learning. Samantha described this as "…intrinsic. They don't expect anyone to give it to them. They just are looking for things all of the time. I think they are always searching for great ideas and things that are engaging." Prior to planning meetings, these teachers prepared questions to ask teacher-leaders or activities to share with their peers, demonstrating a conscious effort to improve their own as well as the community understanding. At the end of the study, when asked to reflect on the planning meetings, Bertha emphasized the importance of teachers' commitment as an impetus for collegial growth:

> I don't think Samantha or anybody has the time to say let's teach somebody how to use this program. You have to be self-sufficient in that way….if you want to be involved, then you have to be accountable also to come with questions or contributions. Otherwise don't come because there are other people who need that time to explore.

Hence, teachers who were interested and committed to their learning and their peers' learning made the greatest contributions to both their own professional growth and the community of practice.

High achieving teachers incorporated resources external to the community of practice as part of their learning and development repertoire. The Internet was frequently accessed to obtain ideas and lesson plan databases that correlated lessons with state standards. They also performed web searches from their home to gather resources for an activity, and became primary contributors of Internet curriculum resources to the school's curriculum links. In addition, teachers incorporated resources from other communities of practice. Colette remarked that she contacted her graduate program peers to gather ideas, ask questions, and share stories; she also brought lessons and strategies from a school were she previously taught. During the study, Michelle enrolled in a graduate course on technology issues, implementing a lesson modeled in that class in her own classroom.

Proficient teachers also "tweaked" resources and incorporated them seamlessly within their curriculum. For example, Roger modified Tara’s worksheet to require less laboratory time while accomplishing similar objectives. Teachers unable to advance beyond introduction or development levels, however, experienced difficulty modifying existing resources. At a planning meeting, Stephanie mentioned she obtained ideas and lessons for an upcoming unit at a conference workshop, but showed no progress in adapting them, citing her busy schedule as a deterring factor. Thus, proficient teachers sought external resources, and evaluated, modified, and implemented them per their instructional needs.

Interactions among high achieving teachers. Figure 4.1 displays the average number of interactions for peer-teachers by their level of development. Individual teachers did not necessarily have more opportunities to interact throughout the study because the teacher-leaders facilitated the experience for all teachers in the community of practice. However, there appears to be a direct relationship between the teacher's ability to design activities and the number of interactions; proficient teachers' made more efforts to seek advice and share ideas.

Insert Figure 4.1 Here

Giving and seeking advice was prevalent among teachers who attained higher levels of development. Bertha and Colette, for example, often asked Samantha to help structure and organization lessons, perceiving meeting time as an opportunity to ask questions rather than for teacher-leaders to "teach." When opportunities arose to ask questions during planning sessions, the more advanced developers assertively asked for peer input, frequently offering unsolicited advice to peers after teacher-leaders answered their questions. For example, during a planning meeting Bertha asked Samantha to suggest resources for a social studies activity; once Samantha responded, Colette offered a few more possibilities even though she did not teach the subject.

Advice seeking also extended beyond the meetings. Tara sought perspectives from more experienced teachers, such as Roger and Chandra, because she wanted to produce good lessons. Advice between teacher-leaders and peer-teachers was primarily given to teachers with more advanced skills. By the end of the study, Samantha voiced concern that lower achieving teachers were not seeking advice, commenting:

> They are not coming to me as I assumed a couple of people would to get help. I don't know if I haven't made them feel that that was an option. I have said that to them, but I don't know if they are not needing help, or if they don't know what to ask.

Successful teachers often shared ideas in different ways. Although all peer-teachers shared ideas when teacher-leaders encouraged such interaction, advanced peers shared more regularly because they accessed more ideas through external resources, such as handouts of student worksheets they created or lessons they obtained on the Internet.

Quality Internet sites stimulated sharing among proficient teachers. On three occasions during planning meetings, Tara shared an Internet resource that inspired her to develop a new learning activity. The community of teachers responded positively to new ideas when they were shared. However, interactions were not reciprocal for less-developed peers. They rarely share ideas voluntarily with the group unless specifically requested by the teacher-leaders. Even during such sessions, many teachers were not prepared to share, or shared only an individual basis. For example, Chandra approached teachers individually to discuss the resource she collected on immigration, but not the group. Hence, some idea sharing may not be reciprocal across the community of practice, especially if less-developed teachers have not invested time to evaluate available resources or develop new resources.

Factors of low achieving teachers. Teachers who failed to become proficient often attributed their lack of interest or success to environmental constraints. In their post-interviews, teachers repeatedly mentioned they lacked sufficient time to develop instructional materials. Instructional innovation gave way to survival, as Deborah remarked:

> I know that technology is important, but I have so much else going on that that gets put on the backburner because it's not pressing at the moment. We just have meetings thrown at us all the time, and paperwork, it's hard to have that extra time to plan a technology lesson when there is so much else to do.

Teachers also noted a lack of access to the computer laboratory. During planning meetings, Samantha told teachers to give a few days notice when planning to use the laboratory. Some teachers reported problems gaining access to the laboratory, however, indicating difficulty estimating the time needed for laboratory instruction. Stephanie described her experience:

> … very hard to schedule time in the computer lab. It's also tough because sometimes it's hard to tell how long something will take to do, like the timeline for how many class periods. Even with my two social studies classes, one class will take a lot longer than the other class. Scheduling that has been frustrating.

Rather than a few days advance notice to schedule the laboratory, teacher reported 2-to-4 weeks were necessary. Some teachers consciously reduced their laboratory time to increase peer access to the laboratory. Colette remarked, "I found another activity I'd like to do, but I want other teachers to use the lab, as well." Teachers needed to coordinate the timing of their lessons in order to reserve sufficient laboratory time. This proved difficult because many were new to teaching and to using technology in their instructional practices.

Access to support resources also influenced the desire to develop technology-enhanced activities. For example, due to family obligations, some teachers requested to use software at home to explore resources for lack of time during and after school. When teachers asked to take the software home, Samantha responded that the school's software license was restricted to school use. Consequently, some teachers perceived insufficient opportunities to learn software others were already using. Other teachers felt the lack of access to resources prevented them from integrating technology into their instructional practices. Stephanie stated, "I don't want to have to take the time and find something, find somebody, find what I need, go get this, and go get that." Stephanie wanted instructional resources to be integrated into the mathematics book or have a manual available in her room; availability was not nearly as important as ready access.

Teacher expectations for their learning environment differed from what was provided. A few teachers wanted more structure and organization to the meetings. For example, Deborah noted that unrelated discussions arose, and that time was not well spent. After talking with other teachers, Colette mentioned that "there weren't opportunities to get their questions asked since some people like to talk about other issues." Deborah suggested that prior to the meeting teachers email the issues to be discussed to choose discussion topics and decide individually whether to attend meetings.

The planning meetings were also of concern. Some teachers wanted additional hands-on experiences where they could explore the resources. Deborah expressed the importance of understanding the tool well: "I need to feel really comfortable with something before I am going to try it in a laboratory, especially in this class because they make me nervous." During one meeting, teachers met to explore a mathematics tool but several reported they had insufficient practice to develop a lesson featuring the tool. One teacher remarked she was not comfortable with any of the tools because she was still learning to use a computer. Some teachers wanted more examples of lessons using these tools followed by group discussion to reflect on their experiences. In addition, a few teachers wanted lessons incorporating instructional strategies aligned with their teaching beliefs, those that could "control what they (students) were doing…avoid wasting time…and need them to be guided (to specific answers)." They also expressed interest in learning to design technology-enhanced lessons in a similar manner, where the teacher-leaders direct the learning of their peers along a pre-determined trajectory.

Interactions among low achieving teachers. Peer-teachers that did not progress well in their development tended to ask task-specific questions and share ideas outside of the scheduled meetings and planning times. Teachers with less developed computer skills required more assistance from peer-teachers and teacher-leaders during and between planning sessions. Roger described one experience:

> She came in late, and she was not able to catch up with us. I knew that Samantha was not able to stop and help her like she probably wanted to, and since she was sitting by me, I showed her step-by-step. As I had an ear on Samantha, I was helping her as well. Just showing her exactly what to do. Also, whenever you are teaching someone, or helping someone learn with software, it's really hard not to do it for them.

Sharing ideas occurred more often outside of planning meetings for some teachers. Deborah stated the planning meetings were unnecessary because there were other avenues to share ideas and lessons, such as at lunch, before and after school, and during bus duty. She noted that ideas are exchanged during informal times of the day, and she would not miss much information by skipping planning meetings. Deborah recognized, however, that some ideas created during shared time in the developmental phase that would not be possible otherwise. Stephanie also did not benefit from the shared planning time. She felt brainstorming during planning meetings was burdensome:

> I find that some people don't always share, or aren't comfortable in meetings. They sit there and go, oh god, it's another meeting that I have to go to. And I got to a point where sometimes I was like that, too.

Instead, Stephanie preferred creative, spontaneous moments during informal encounters and reflection. She was not concerned about the lack of structure or commitment to do such tasks, noting "If I want to do something, then it doesn't (get set aside)." Interestingly, teachers who believed idea sharing was more effective outside of planned meetings produced fewer lessons than most of their peer counterparts.

All peer teachers improved their understanding and design of technology-enhanced learning environments. Proficient teachers were motivated to use resources to provide the best possible learning experience while others lost focus due to the time demands. Responsibility for learning also differentiated success, with high achieving teachers viewing learning as ongoing and self-regulating as they prepare for meetings, seek additional resources, and explore tools independently and collaboratively. High-achieving teachers regularly shared ideas and questions with the entire group while low-achieving teachers expected teacher-leaders to direct their learning and development. They attended meetings to obtain resources or activities for their classrooms, but not to contribute to the community. As a consequence, several lost interest and did not pursue learning experiences outside of scheduled meeting times.

Mentoring

Peer mentoring emerged as a critical component that affected the professional growth of teachers in the community of practice. This section summarizes the factors and interactions that influenced peer development through the mentoring relationships.

Factors. Reflection, interpersonal relationships, and feedback influenced teacher-leader interest and their ability to support peer growth. Reflection relates to the teacher-leaders' awareness of their peers' development. Lack of careful reflection led to missed opportunities. During the fourth planning meeting, while some teachers were prepared to progress in their development, the teacher-leaders modeled lessons and demonstrated software applications. At the meeting, Tara asked, "If the kids come in for writing, can I use this for technology? I'm running out of ideas." The teacher-leader replied that using computers for word processing was acceptable since it was consistent with the district's writing standard, but that it was not the scheduled activity. The teacher-leaders neither shared writing ideas nor followed up subsequently to support Tara's interests. Tara reported she often created technology-enhanced lessons without the assistance of the teacher-leaders, sometimes consulting with nearby peers.

As the study progressed, the teacher-leaders continued to share ideas and model lessons without changing strategies for the next phase. The introduction phase was scheduled for three weeks, but resulted in eight weeks and could have extended even longer. Even though teacher-leaders kept a reflective journal, they lacked avenues to coordinate the planning sessions. Once, Rebecca stated that she did not consider organizing the group session activities until she was driving to work. On another occasion, the teacher-leaders discussed planning session activities in the hallway minutes before they started.

Faced with stalled teacher growth, the researcher met with the teacher-leaders for a 45-minute reflective session not initially planned for the study. During the session, the teacher-leaders realized their peers were not progressing to their goal of independently developing technology-enhanced lessons. This session enabled the teacher-leaders to consider alternative activities, from modeling to collaboratively designing, per subsequent phases of Collaborative Apprenticeship model. As a consequence, peer-teachers' roles shifted as they assumed greater responsibilities in the design process. Two additional reflective sessions were convened later in the study to help teacher-leaders develop their own strategies to facilitate peer development during the planning sessions. Teacher-leaders expressed awkwardness about confronting peers on their lack of progress. Both teacher-leaders stated that approaching their peers was challenging because they did not want to be portrayed as an authority figure. Rebecca described her reasoning: "You never want to say something to offend anybody, because you would like to work with them. You would never want to say anything that would make them think you thought little of their ability. Because I don't." Instead, teacher-leaders preferred to be regarded as a supportive peer where they respected the professionalism of the peer-teachers, assuming they would seek help when needed.

It was important for the teacher-leader to develop rapport with peers before discussing sensitive issues. On one occasion, Rebecca approached a peer who had not been meeting minimal school requirements to use the computer laboratory. She chose not to confront the peer directly about this issue, but instead indirectly incorporated the difficult issue into a casual conversation: "It kind of gives you an 'in' to go talk to someone if you know what they have been doing in their life away from school, instead of going in and just saying 'can I talk to you about technology?'"

Teacher-leaders preferred to provide feedback collectively rather than individually. Rather than evaluating work during shared planning time, they asked questions about instructional strategies, assessment, and technology resources used to help teachers reflect on their lesson. Teacher-leaders questioned rather than assessed because they did not feel comfortable serving as the “judge” of their peers' work. They wanted their peers to ask questions to promote reflection and community-wide feedback. However, during feedback sessions, questioning was primarily between teacher-leaders and an individual peer-teacher. When finished, teacher-leaders praised each teacher's work, regardless of its quality. Feedback as praise was also given when teachers shared lesson plans with mentors outside of planning meetings. For example, Samantha told Colette by email that she did a great job on her Webpages, and also offered a few suggestions for revision.

Interactions. Teacher-leaders gave advice in collective settings, and promoted motivating and reinforcing behaviors as a means to encourage peer growth. Rebecca's advice focused on curriculum issues and instructional strategies. As both a teacher-leader and a fifth grade teacher, she drew on experience to recommend "do's and don't's" for particular activities. Samantha, on the other hand, gave advice about technical issues, using particular software and design strategies. During planning sessions, both teacher-leaders contributed whenever they considered it appropriate, and were not necessarily bounded to their areas of specialization. However, teacher-leaders were reluctant to give advice to teachers outside of the planning meetings unless it was requested. They seldom approached teachers to see if they needed help, and many of the teachers did not seek advice as they had independent time to develop activities.

The highest and lowest achieving teachers received the most motivating and reinforcing effort from teacher-leaders. Highly productive peer-teachers often received praise publicly in planning sessions or as a group email to the grade level teachers. Teacher-leaders used this strategy to motivate peer-teachers to maintain ongoing dialogue and support, especially between peer-teachers at various skill levels. Positive peer feedback cultivated continued interest in designing and developing activities. During her post-interview, Tara noted she was motivated to create more lessons incorporating web resources. Positive comments from experienced teachers made her feel she was offering substantive contributions to the teaching community.

Teacher-leaders provided encouragement continuously to peer-teachers who had not progressed out of introduction level development in order to increase their confidence. In their post interviews, the teacher-leaders expressed concern over the slow development of these teachers, but excused their lack of growth to restricting factors, such as lack of knowledge or time. In essence, the teacher-leaders continued to believe these teachers eventually would progress in their development. Teachers at the developmental level, however, received little encouragement from teacher-leaders outside of planning meetings. In their journals, the teacher-leaders described them as being fairly independent in technology use, but unsure of what they were doing. Samantha noted that some teachers did "not usually ask questions or look to me as a resource for using the labs." Hence, teacher-leaders used encouragement as an interaction strategy to offer ongoing support to peers most in need.

Discussion

Maintaining a cohesive and productive community of practice (Wenger, 1998) was challenging for teacher-leaders. They orchestrated a learning environment with collaborative activities, reinforcing attributes of *shared repertoire* and *mutual engagement*, where teachers had the opportunity to advance from the introduction phase to the proficient phase of Collaborative Apprenticeship. However, due to the aforementioned factors that influenced interactions, some teachers failed to engage *joint* *enterprise* by not attaining this level of development. Consequently, teacher-leaders were confronted with scaffolding peers that had different needs and objectives. Instead of legitimate participation in peripheral and supportive ways (Lave & Wenger, 1990), some peer-teachers were expected to participate as equals but were unprepared to do so. For example, when after eight weeks the teacher-leaders started to transition into collaborative planning, not all teachers were developmentally ready. Some teachers had not yet implemented the activities modeled in their planning sessions and were unable to contribute effectively as collaborators. In contrast, higher-achieving teachers had already designed classroom activities, demonstrating greater readiness and proficiency. Teacher-leaders organized planning activities under the assumption that teacher growth would progress at the same rate, when in reality considerable variability was observed. As collaborative planning progressed, those teachers stalled in the introduction phase encountered difficulties planning lessons with peers and implementing lessons in the computer laboratory—activities beyond their capabilities and experience.

Teachers who were unsuccessful at the developmental level were challenged even more as the activities progressed. During the proficient phase, they took little time to independently explore uses of technology or create activities like those modeled during the introduction phase. Instead, their lessons focused on basic skills rather than gathering information and supporting thinking. When expectations were raised, some teachers decided not to participate fully in the study, partly due to limited success in completing developmental level activities. Alternative explanations for the teachers' departure could have related to their lack of time and motivation to participate once they were held accountable for designing a large portion of the lessons. Proficient teachers, in contrast, produced lessons throughout the project using computer software as a tool that supported student thinking.

Some peer-teachers had difficulty progressing because teacher-leaders did not adapt to their varied learning needs by modifying interactions or factors critical to their development. For example, Sandholtz, Ringstaff, and Dwyer's (1994) research on collegial interaction and adoption of technological innovations identified the need for emotional and technical support during early development, with collaborative and instructional support for more advanced learners. Thus, teacher-leaders in this study could have sought additional approaches and alternative methods to support peers that were lagging. Mentors' flexibility to respond to individual peer needs is important in supporting teachers' development and technology integration (Kariuki, Franklin, & Duran, 2000).

The lack of progress of some peer-teachers can also be attributed to a focus on attending to their individual needs rather than engaging in joint enterprise. Low achieving teachers were typically concerned with time constraints to complete individual tasks, their first priority, to the extent they were unable to support their peers' learning or develop resources for the community of practice. Reciprocal interactions for these teachers supported each other's individual needs instead of those of the collective community. For example, sharing ideas and brainstorming were effective during informal moments when peer-teachers addressed an issue related to *their* class or idea for an upcoming lesson. Thus, less successful peer-teachers interacted to support their own development but contributed less to their peers' development or the goals of the community of practice.

In contrast to their less successful peers, proficient teachers engaged in joint enterprise throughout the study. This subset of teachers continued to share ideas and provide feedback to their peers, even while they were designing technology-enhanced lessons independently. Moreover, they interacted with less successful teachers in an effort to brainstorm ideas for their lessons and improve their skills, illustrating an interest in collective goals rather than personal goals. The self-reliance encouraged by teacher-leaders at the proficient phase did not isolate these peer-teachers; instead, they gradually acquired experiences developing, supporting, and interacting in preparation as a future teacher-leader. In this case, peer-teachers prepared for new teacher-leadership and sustaining the technology integration effort through legitimate, peripheral participation (Lave & Wenger, 1990).

Researcher involvement affected teachers' development indirectly, even though there was minimal interaction with teachers. In this study, a researcher participated occasionally to induce teacher involvement and attention to professional learning goals. On one occasion the researcher arrived to school a few minutes late for observation; the meeting was cancelled even though he did not contribute to the planned group activities or interact with its members. Rebecca stated the cancellation was a response to teachers' anxiety, but Samantha later indicated that the meeting would have been shortened, and not cancelled, if the researcher were present at the start of the meeting. The abrupt cancellation suggested that the participation was externally driven, even though teacher-leaders managed the strategies and activities. Some teachers, like Bertha, suggested that teachers should not allow external factors to qualify participation: "When you volunteer for something, you don't realize that you have to make the commitment. You just have to make the time to do something."

Teachers expressed various perspectives about the Collaborative Apprenticeship model as a strategy for technology integration. Those satisfied with their experience enjoyed the opportunity to work closely with the teacher-leaders. Several experienced teachers and the technology coordinator felt that the professional development opportunity was excellent for new teachers, reinforcing that technology was integrated into the curriculum. Experienced teachers valued opportunities to learn ideas generated by new teachers.

Those who did not value the experience, in contrast, generally did not consider the time to be well spent. Some teachers wanted more modeling and others greater structuring of the meetings, suggesting that organization and direction were the teacher-leaders' responsibility. The assumption, that teacher-leaders were prepared to mentor based on previous experience in mentoring other teachers and integrating technology into their classrooms, was not sufficient to ensure successful mentoring relationships. Teacher leaders also needed to adapt to peers' learning styles and develop expectations collectively. In addition, teacher-leaders, challenged by their dual role as a peer and authority figure, rarely provided explicit direction for teachers' learning due to concern that confrontation might jeopardize peer relationships. This finding was consistent with Smylie and Denny's (1990) research on teacher leadership in school social structures, where teacher-leaders expressed concern over an "elitist" perception of their role. Troubled with this belief, one teacher-leader in the study noted, "I want the role and responsibility, but I don't want to be different from other teachers" (p. 254). A different perspective on this issue relates to gender, since women can be less direct in their communication than men (Belenky, Clinchy, Goldberger, & Tarule, 1997). Clearly, alternate strategies are necessary to prepare teacher-leaders to enhance peer communication.

Implications for Research and Practice

The potential of Collaborative Apprenticeship needs to be explored in new forms, such as through longitudinal studies, mentoring strategies of teacher-leaders, and developing joint enterprise.

Longitudinal analysis. This study explored factors and interactions related to teachers' development in technology-enhanced learning. Although the study revealed different forms of teacher development, the Collaborative Apprenticeship model was not explored or implemented in its entirety. During the mastery phase, for example, peer-teachers become mentors of their peers—critical to self-sustaining leadership. Several of the peer-teachers at the end of the study expressed interest and willingness to mentor peers in their technology use. Future research should examine how mentoring relationships evolve in a teaching community of practice, how strategies are shared, and how to support the transition between and among generations of teacher-leaders. In addition, further research needs to examine how teachers' learning and participation in a community of practice is impacting student learning, and how the researcher's methods influence their learning and participation. Additional data sources are needed to provide this understanding, such as classroom observations and students' assessment. Ultimately, teachers' contributions are often motivated more by student success in the classroom than by sustained program priorities (Franke, Carpenter, Levi, & Fennema, 2001).

Mentoring strategies of teacher-leaders. The teacher-leaders in this study were selected based on their prior success and experience in mentoring and integrating technology into their instructional practices. By coincidence, they were also well-respected teachers in the school. However, teacher-leaders described their role as awkward. They helped reactively when asked instead of proactively monitoring peer progress and offering constructive feedback. Teachers who focused on students' learning often sought and obtained help from teacher-leaders, but others did not learn the skills and strategies needed to independently integrate technology into their practices. To develop all teachers across the community of practice, teacher-leaders need to devise strategies to intervene with peers who are not progressing, and also find ways to learn from peer-teachers. Perhaps teacher-leaders need additional experiences or training that incorporate these strategies to prepare them for peer mentoring responsibilities.

Establishing Unity. Communities of teachers need to cultivate joint enterprise. Enthusiasm for the planning activities was related to the perceived benefit of discussions or instructional materials. Intrinsically motivated teachers regarded planning meetings as opportunities to ask questions and share ideas with their peers. Others, however, suggested that planning time was not used efficiently to scaffold learning or develop activities. Hence, the different expectations resulted in goals that were not shared across teachers, but were instead driven by teacher-leaders. To promote joint enterprise among teachers, teacher-leaders need to develop techniques, such as involving peer-teachers in decision-making and planning that will foster collective understanding and desire for particular outcomes and learning methods. Motivation also affects collective enterprise.

Future research should examine whether implementation of the model influences teacher motivation, and how teachers cultivate unity among their less motivated peers.

Limitations

Several limitations are noteworthy. First, data were collected primarily during planning meetings, and do not account for informal interactions throughout the school day. As a result, we relied on interviews, reflection statements, and email exchanges to identify other interactions. Moreover, data do not reflect the impact Collaborative Apprenticeship had on teacher lessons or student learning since the nature of this study focused on teachers' learning. Next, since the research design was not comparative in nature, factors and interactions cannot be attributed directly to Collaborative Apprenticeship. In addition, the research design could not draw causality inferences, such as whether Collaborative Apprenticeship stimulates or distracts motivation of teachers. Although interactions were not distinguished from reciprocal interactions in this study because the underlying framework assumed that participation involved mutual support, it seems likely that sometimes teachers also provided assistance without intent to deepen peer understanding. Finally, since the analysis was bounded to a single case, the findings may be of limited generalizability; however, the identified factors and interactions may be useful to reflect on mentoring and technology integration in other communities of practice.

Conclusion

The success of the Collaborative Apprenticeship approach is dependent upon reciprocal interactions, related factors, and mentoring relationships within a teaching community of practice. The approach stimulates interactions for professional learning and mentoring featuring onsite, ongoing, and just in time support. Although the community of practice received support of this nature, two-thirds of the teachers were hampered by the absence of key interactions and confounding factors. Mentoring promoted peer development when interactions were communal, but seldom demonstrated the benefit of private interactions.

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Table 4.1

Participant[10] Profiles

Teacher	Years at School	Planning Group	Role	Entry Level	Completion Level	Factors and Interactions That Supported Development	Factors and Interactions Hampering Development
Samantha	8	1st and 2nd	Teacher-Leader	Mastery	Mastery	giving advice, human resources, respect	reflection, connection to group, connection to individual
Rebecca	4	1st	Teacher-Leader	Mastery	Mastery	connection to individual	proximity, reflection
Bertha	2	2nd	Peer-Teacher	Introduction	Reached Proficiency	responsibility, human resources, social obligation	physical resources, priority
Michelle	3	1st	Peer-Teacher	Developmental	Reached Proficiency	shared time, sharing ideas	accessibility
Roger[11]	3	1st	Peer-Teacher[12]	Ready for Mastery	Ready for Mastery	connection to individual, curriculum	individual time
Tabitha[11]	0	1st	Peer-Teacher	Introduction	Introduction	connection to individual, caring	lower-order thinking, connection to group, shared tasks
Stephanie	0	1st	Peer-Teacher	Introduction	Reached Developmental	connection to individual, human resources	priority, accessibility, learning beliefs
Deborah	0	1st	Peer-Teacher	Introduction	Reached Developmental	connection to individual, open-mindedness	shared time, priority, organization
Tara	0	1st	Peer-Teacher	Introduction	Ready for Mastery	positive reinforcement, sharing ideas, human resources	learning beliefs
Chandra[11]	0	1st	Peer-Teacher	Introduction	Introduction	human resources, connection to individual	individual time, teaching beliefs, connection to group
Colette	0	2nd	Peer-Teacher	Introduction	Ready for Mastery	physical resources, human resources, assertiveness	connection to group

From Glazer & Hannafin (2003a)

[10] Pseudonyms were assigned to participants to protect their confidentiality.
[11] Discontinued participation in the study after 15 weeks.
[12] Also served as the grade-level chairperson.

Table 4.2

Teachers' Contributions to Development of Technology-Enhanced Activities

Number of Weeks	Technology Integration Phase	Teacher-leader Roles	Peer-teacher Roles	Collaborative Partnership	Activities Completed
Eight	Introduction	Promotes and models use of technology in workshop or classroom environments	Observes and participates in learning applications of technology	Discuss and reflect on learning and design experience	Three
Seven	Developmental	Provides scaffolding, coaching and fading to design, develop, and implement learning activities	Acquires software and design skills in context of participation	Collaboratively design, develop, and implement technology-enhanced learning activities	Three
Eight	Proficient	Identifies areas for improvement and exploration	Articulates understanding by autonomously designing activities	Share experience and ideas with peer community	Two
Not completed in study	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	NA

From Glazer & Hannafin (2003a)

Table 4.3

Example of Organization Chart of Coded Data

	Type	Example(s)	Data Example
Reciprocal Interactions	Story Telling	classroom experiences, student actions, teachable moments	During an observation, Sarah gives examples of how students have been making mistakes and losing their work.
	Backscratching	task completion	Andrea mentioned in her post-interview that teachers create instructional materials and make photo copies for one another.
	Discussing and resolving conflict	student behavior problems, instructional challenges, resource access	Teachers address problems with students' attention span during a meeting. They offer strategies to minimize students' hyperactivity.
	Brainstorming	soliciting ideas, devising lessons collaboratively	The group devises a set of possible student products for the next lesson they will plan together.
	Giving/seeking advice	student learning needs, curriculum connections, instructional strategies	Samantha suggests to Bertha that she use a different website for her lesson to avoid advertisements.
	Modeling	teaching lessons, talking about design strategies, demonstrating software	Rebecca and Samantha explain to the teachers the various components involved in a technology-enhanced lesson.
	Sharing ideas	lessons, instructional resources, web sites	During a planning meeting, Tara told the teachers about an interesting website she found that can be used for an upcoming health unit.
	Motivating	verbal encouragement, physical expression	Samantha told Tabitha that she was excited to see her sign up for the lab on her own.
	Posing/responding to questions	computer skills, procedures, information	Stephanie asked Roger how to set up the Everkey unit in her classroom to show her students computer demonstrations.

Table 4.3 (cont.)

Factors	Affect	caring, anxiety level, patience and sensitivity, enjoyment, connection to group, friendly climate, connection to individual, respect	Rebecca approached Chandra to discuss her use of the computer lab, but not until after they talked about her family.
	Beliefs	teaching, learning, instructional design, social obligation, self-efficacy	Bertha needed to explain the social studies curriculum to her peers because others have helped her in the past
	Environment	proximity, shared time, individual time, human resources, physical resources, accessibility	Stephanie said she did not use the math software because she could not locate a resource manual easily.
	Culture	leadership, professionalism, curriculum, mutual responsibility, peer feedback, shared tasks	Samantha and Rebecca asked questions to each group member as they shared their lessons. The questions targeted areas where teachers needed to provide more information or modify their lesson.
	Cognition	common understanding, priority, awareness of learning behaviors, lower order thinking, higher order thinking, reflection	Stephanie did not attend the meeting because she had to complete an administrative task before the end of the day.
	Personality	assertiveness, motivation, responsibility, autonomy, availability, open-mindedness, organization	Tara was excited to see that other teachers were using her lessons. In her postinterview, she expressed interest in designing more of them because she knew she was making a difference with her peers.

Adapted from Glazer & Hannafin (2003a)

Table 4.4

Overview of Findings

Major Finding	Secondary Finding	Examples
Factors evident among high achieving teachers	i. motivated ii. focused on students' learning iii. took responsibility for their learning iv. involved many resources outside of their local community	i. work closely with experienced peer; obtaining positive feedback ii. student motivation; teacher satisfaction with student work iii. preparing for meetings; commitment to group learning goals iv. Internet resources; lesson databases; resources from other communities; able to modify existing resources for personal use
Interactions among high achieving teachers	i. greater frequency of interactions ii. advice seeking iii. share ideas	i. seek input; offer suggestions ii. from more experienced teachers; skill development iii. instructional resources; Internet sites
Factors evident among low achieving teachers	i. lack of time ii. access to the computer lab iii. access to support resources iv. opportunity to obtain help v. learning during planning meetings	i. other obligations; pressure to commit; need human resources ii. needs advanced planning; coordinate time in lab iii. taking software home; locating manuals iv. could not ask questions at meetings v. needed more hands-on experiences and models of lessons
Interactions among low achieving teachers	i. high proportion of task-based questions ii. idea sharing outside of shared time	i. developing computer skills; needing ongoing assistance ii. during lunch; when mind is not concerned about other tasks
Factors affecting mentoring relationships	i. reflection ii. interpersonal relationships iii. feedback	i. teacher-leader awareness; devise strategies for peer development ii. fear of authority; desire to be supportive peer; focus on strengths iii. collective questioning; little evaluation of peer work; positive feedback
Interactions affecting mentoring relationships	i. advice in collective settings ii. motivating and reinforcing	i. curriculum issues, instructional strategies; resources; technical issues ii. given to high and low achieving teachers; little given to those in developmental level

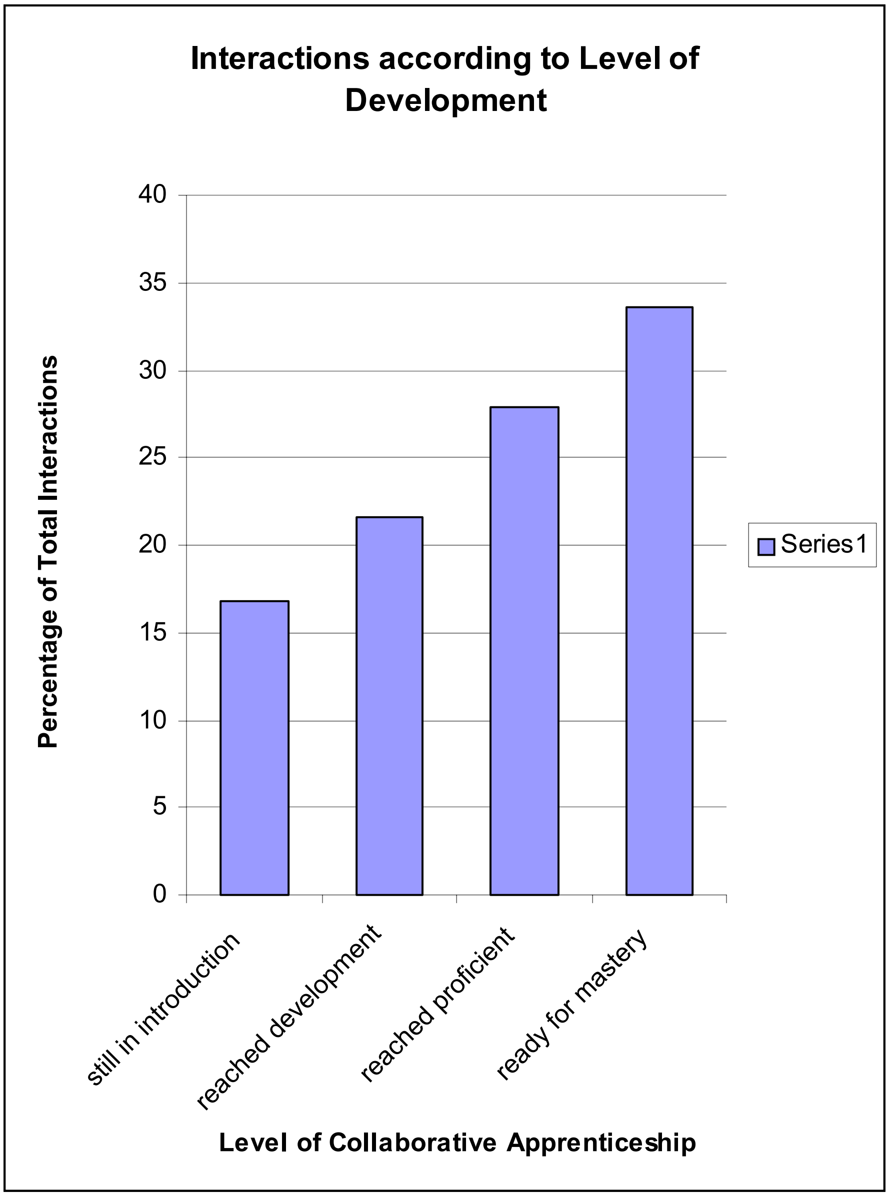

Figure 4.1. The relative proportion of interactions per peer-teacher according to their level of development at the end of the study.

CHAPTER 5

TRANSFORMING TEACHERS' USE OF TECHNOLOGY:

A TECHNOLOGY COORDINATOR'S ROLE IN THE PLANNING PROCESS[13]

[13] Glazer, E. M., & Page, K. To be submitted to *Leading and Learning with Technology*.

Many teachers use educational games and skill-based software without clear or compelling reference to classroom lessons (Becker & Riel, 2000). Some computer-based activities, while addressing district and state standards, do not engage students in learning as much as they allow students to practice basic skills (Ertmer, 1999). Unfortunately, some teachers do not use technology tools that promote creativity, allow exploration, and provide opportunities for evaluation. Instead, teachers and students sometimes regard 'field trips' to the computer lab as a release from classroom routine rather than an opportunity to strengthen and extend learning opportunities.

While computers may motivate some students to learn, technology coordinators strive to promote thoughtful use of technology to support students' learning. In this article, we view the technology coordinator as responsible for providing leadership and support in the use of technology in teaching and learning. He or she organizes and coordinates professional development related to teachers' individual use and classroom integration of technology. The technology coordinator has opportunities to interact regularly with teachers, either during planning meetings, with their classes in the computer laboratory, or through staff development workshops. In addition, he or she is accessible to meet with teachers one-on-one or as a group by appointment.

According to the NETS standards for teachers, teachers should, "implement curriculum plans that include methods and strategies for applying technology to maximize student learning" (ISTE, p. 9, 2000). Teachers need instructional support in their planning since 'field trips' to the computer laboratory rarely incorporate instructional methods to guide learning. For example, they may be unfamiliar with how to design lessons that require students to interact with computers to gather information, formulate hypotheses, and explain findings. This task is nontrivial to many teachers, suggesting that staff development is important to help teachers provide rich learning experiences. However, many staff development opportunities in the form of mini-workshops only reach a small cross-section of teachers, those intrinsically motivated to remain after school and learn to improve their instructional practices, unless mandated to do so.

Traditional staff development frameworks have other drawbacks. In our elementary school, for instance, it is difficult to discuss curriculum issues because participants teach at different grade levels or different content areas. As a result, the lack of shared professional responsibilities promotes individualized learning but not collective understanding. In addition, most teachers attending these workshops are novices. They lack opportunities to work with peers who have attained a higher degree of success integrating technology into their curricula. Consequently, the novice teacher assumes largely independent responsibility for seamlessly and independently devising technology-enhanced lessons that fit well into his or her curriculum.

Since teachers do not necessary understand strategies to integrate technology into their curriculum, professional learning requires more than access to technological expertise and support. In addition to technical support, teachers need peer coaches who will model design practices, share instructional strategies, and provide feedback to teachers as they develop technology-enhanced lessons. In return, the peer coach benefits from the mentoring relationship by examining the teachers' different uses of technology and the integration strategies used in other classrooms. Collectively, teachers benefit from systemic initiatives, such as peer coaching, because they enhance collegial engagement and the collaborative development of new ideas (Becker & Riel, 2000).

Thus, a mechanism for orchestrating and sustaining professional relationships is needed to improve technology integration across a community of teachers.

Collaborative Apprenticeship

Collaborative Apprenticeship (Glazer & Hannafin, 2003) is a professional development model we have used that involves supporting and mentoring a professional community. The framework stems from Collins, Brown, and Newman's (1989) *cognitive apprenticeship* model, in which ongoing mentoring involves the gradual sharing of strategies, and Wenger's (1998) *communities of practice*, which focuses on key factors in the development and growth across individuals in a collective unit. Through Collaborative Apprenticeships, novices work closely with more experienced peers until they can independently design, develop, and implement technology-rich lessons within their curriculum. In this paper, we describe strategies for using the model within a K-5 school setting and reflect on the challenges in providing ongoing support and development for teachers as they integrate technology into their instructional practices.

Criteria for Using Collaborative Apprenticeship

Effective technology integration requires shared time, a commitment from teachers, a variety of experience levels with classroom technology use, and a structured agenda surrounding a shared curriculum topic.

Shared time. A common planning time enables teachers to share ideas used in the past and to develop new ones collaboratively. Because many teachers have after-school obligations and in order to reduce attrition, we chose to conduct a bi-weekly meeting during the school day. We find this meeting schedule sufficient to maintain commitment and momentum without overwhelming the teachers. During the shared time, experienced technology users model past lessons, discuss anticipated challenges, and explain strategies to design a lesson. The shared time provides an opportunity to brainstorm new ideas and plan lessons collectively with the support of a more experienced peer and the technology coordinator. In addition, shared sessions provide time to demonstrate and practice software and Internet tools available in the building.

Teacher commitment. Teachers who are successful in designing technology-enhanced lessons prioritize their learning and development as a part of their repertoire. They 'make space' in their schedule and prepare technology-related questions and ideas to expand the collective understanding of the teaching community. When teachers are well-prepared for group meetings, their peers are exposed to new ideas, questions and answers they have not yet considered, and receive advice on their work. The school district provides two staff development units toward maintaining teaching certificate to acknowledge the teachers’ contributions.

Teacher experience. Diverse technology experience across the community affords fertile ground for collaborating and learning. More experienced teachers can mentor peers, explain curriculum connections, and model successful lessons; novices can brainstorm and contribute new ideas based on fresh perspectives and enthusiasm. The technology coordinator participates as an advisor to the teachers' work, giving feedback and advice to support development, occasionally introducing design strategies or software helpful in addressing teachers' needs, and promoting their professional growth.

Structure. An organized, goal-directed agenda provides a clear purpose for attending and participating in planning meetings. Teachers need confidence that meetings are personally and professionally beneficial to them because they require time normally allocated to other tasks and responsibilities. Without clear meeting outcomes, teachers may shift the focus to other school issues instead of contributing technology-related ideas to the group. Consequently, some teachers may lose motivation to participate in the meeting if they perceive their needs are not being met. To help focus group involvement, we recommend that mentors utilize a goal-driven agenda that is determined collectively by the group. Prior to meetings, mentors ask peers to brainstorm discussion topics and questions so that the shared time addresses common needs and desired outcomes.

Teacher's Learning and Development

As illustrated in Table 5.1, teachers progress through four developmental phases, each with evolving roles and responsibilities. Based on our experience, we propose that the first three phases be accomplished in nine-week intervals; the last phase is ongoing throughout the teachers' careers. Throughout the process, experienced teachers serve as mentors to peers within their grade level, and the technology coordinator consults with the groups by giving advice, sharing strategies, and providing feedback. We use a three teacher to one mentor ratio to keep group size intimate enough for teachers to feel comfortable sharing stories and challenges, raising questions and concerns, and focusing on shared curriculum topics.

Insert Table 5.1 Here

Introduction. The introduction phase helps teachers to become comfortable with technology tools and their classroom use. In lab group meetings, mentors facilitate by modeling "expert" activities, discussing instructional strategies, and providing hands-on experiences to help teachers to anticipate and address student questions. For example, mentors might teach a lesson about coral reefs, where teachers act as students and gather information on the Internet to support an argument. Teachers apply activities in their classrooms, and when possible, receive feedback from a peer observer. In an effort to increase comfort levels and to minimize problems, participants co-teach lessons with the technology coordinator when using particular software for the first time.

Developmental. Teachers learn to design a technology-rich lesson by collaborating with their mentors. The technology coordinator works closely with mentors to develop a shared understanding of key lesson components, such as objectives and standards, student strengths and weaknesses, intended outcomes, prerequisite content, technology use, pre-lab discussions, time management issues, and assessment tools. Each mentor identifies a topic based on a curriculum weakness, and talks through the lesson design process with peer teachers. All teachers collaborate in the process by assuming responsibility for different parts of the lesson, such as finding website resources, writing student questions, and identifying related district standards. As the mentors organize their ideas, the technology coordinator provides advice and feedback to enhance the lesson. The teachers then implement the lesson in their classrooms, reflect on their experiences, and repeat the design process with progressively less mentor guidance. Hence, the mentors' role gradually shifts coach who consults on peers work as the teachers gain experience.

Proficient. In this phase, teachers become more autonomous in their use of technology. They develop lessons independently, occasionally consulting with their peers, mentors, and technology coordinators. For example, teachers might share an activity they designed prior to implementation, seeking informal feedback or alternative assessment ideas. The teachers meet less often with their group, but mentors continue to promote peer development through informal interactions or planned meetings. Teachers are expected to generate original ideas, implement them in their classrooms, and share them with their community. Teachers "mature" in this phase when they can design a lesson that fits well in their curriculum, enhances student learning beyond what is accomplished in the classroom, and develop and implement lessons with minimal support. Teachers maintain their design and development skills when they are encouraged to continue implementing technology-enhanced lessons. We found that the duration of this phase varies considerably, from as little as four weeks to more than a year, depending on each teacher's confidence and experience in the classroom.

Mastery. Once teachers feel competent in their design skills and comfortable leading lessons without support, they are encouraged to mentor other teachers at their grade level. Since all teachers do not progress at the same rate, it is important that teachers who become proficient quickly support their peers. Over time, the cycle continues. The technology coordinator continues to work closely with new mentors, providing strategies to promote the ongoing development of their peers.

Challenges and Strategies

Through our implementation and revision of the Collaborative Apprenticeship, we have identified five challenges, as well as strategies to help overcome them.

Cultivating Peer Mentoring

Some teachers feel uncomfortable about mentoring peers, or about being mentored from peers, because they engage in new roles and responsibilities. Teachers may not be familiar with orchestrating their peers' learning, offering advice to a more experienced teacher, or giving critical feedback on teachers' lessons. Mentors should be chosen based on their success in the classroom and their interpersonal skills because they are cultivating a trusting relationship with their peers. Once mentors have been selected, we suggest the following strategies to cultivate mentoring relationships with peers:

- Learn about peers on a personal level to build trust and collegiality.
- Develop shared goals and expectations with peers about the mentoring relationship and outcomes.
- Engage in mutual tasks, such as designing lessons collaboratively, so peers can understand expectations, learn strategies, develop ideas, and ask questions with a more experienced peer.

Overcoming the Support Role

In deference to teacher autonomy, mentors often expect teachers to seek assistance when it is needed. However, even when teachers do not seek support, technology coordinators and mentors should monitor and provide assistance to those who are not progressing towards individual and collective goals. The reluctance to intervene arises from concern that teachers might be intimidated, diminishing collegial and interpersonal relationships. The following strategies can be used to promote comfortable, professional interactions that promote peer development:

- Talk about “horror stories” related to technology integration to convey that all teachers make mistakes – but the good ones learn from them.
- Invite teachers to observe lessons that exemplify successful and energetic student learning experiences.

- Set up one-on-one sessions outside of the group meeting to provide a less threatening forum to review and reinforce strategies.

Addressing the Complexity of the Teacher's Day

Teachers value available time because they are inundated with daily tasks. Many are hesitant to participate in staff development because of time constraints and unsatisfactory past experiences. The following strategies can be used to optimize time and benefit of planning meetings:

- Promote systemic thinking by asking teachers, prior to the meeting, to identify their individual goals and areas of interest.
- Devise a focused agenda that addresses each teacher’s needs to demonstrate a clear impact on individual as well as community development.
- Recruit experienced, respected and personable teachers as mentors so the community will assume ownership of the teachers' development.

Promoting Administrative Support

Administrator support is vital to teachers' learning and development. We recommend the following tactics to initiate and maintain administrative interest:

- Invite administrators to group planning sessions to witness the collaboration and brainstorming.
- Encourage administrators to observe lessons that illustrate how technology can be used to enhance students' learning.
- Incorporate a technology component to a PTA meeting, where students share their work and positive experiences involving technology.

Coping with Different Teacher Personalities

Teachers have different learning styles and perspectives that influence their development. Some assertively seek answers to questions, while others avoid questioning for fear of embarrassment. A technology coordinator or mentor can support different teacher personalities through their communication and approachability. Strategies include:

- Respond positively to teachers' questions, even if the same questions have already been asked and answered.
- Send emails to teachers to share ideas, provide reminders, and let them know you are always available for help.
- Give positive feedback on a continual basis, noting the growth in all teachers.

Reflections

Professional development through Collaborative Apprenticeship has given us a fresh perspective on how teachers can receive ongoing support in their efforts to design technology-enhanced lessons. The coordinator's role has shifted from supporting teachers in the lab to being proactive in promoting effective technology-enhanced lessons. Several unanticipated outcomes arose in the planning time. First, the technology coordinator had opportunities to offer advice that could improve lessons as ideas originated, instead of solely responding to a teacher's inquiry. In addition, the teachers asked a broader range of questions than expected related to curriculum and design issues; in the past, teacher questions typically involved technical issues about using particular software. Most importantly, the technology coordinator became an instrumental member of the planning team as teachers shared ideas, solicited input, and asked questions. This provided a fresh perspective to teachers' use of technology because previous professional development workshops focused on teachers' products instead of a more important issue – their learning. Overall, the technology coordinator’s participation as a member of the community has helped to overcome the image of technology as a free-time 'field trip', reinforcing it as instrumental in supporting and enhancing students' learning.

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Table 5.1

Peer mentoring roles and responsibilities in Collaborative Apprenticeship

Participant	Introduction Phase (9 weeks)	Developmental Phase (9 weeks)	Proficient Phase (9 weeks +)	Mastery Phase (ongoing)
Peer Mentor	- Model successful lessons - Recommend instructional strategies	- Coordinate collaborative work - Discuss design strategies	- Encourage exploration and reinforce effort - Provide advice and feedback	- Stop monitoring peers' development - Offer advice and feedback when requested
Peer Teacher	- Hands-on learning - Apply model lessons in classroom	- Design components to a new lesson - Acquire more responsibility gradually	- Design full lessons - Rely less on mentors and technology coordinator	- Assume mentoring responsibility - Continue exploring new uses of technology
Technology Coordinator	- Demonstrate software - Co-teach, assist, and observe in lab	- Develop design strategies with mentors - Provide advice and feedback to mentors and teachers	- Encourage self-reliance in lab - Reflect on progress with mentors	- Recruit and coach new mentors - Oversee continued teacher development and technology integration

CHAPTER 6

CHALLENGES AND STRATEGIES TO PEER MENTORING[14]

[14] Glazer, E. M. To be submitted to *Phi Delta Kappan*.

Abstract

Peer mentoring offers many promises for ongoing professional development in schools today. Mentors have opportunities to take on leadership and coaching responsibilities to help their peers to become familiarized with the culture of the school, learn instructional strategies, and adopt innovative practices. In addition, protégés engage in learning experiences with peers who share similar responsibilities, including a common curriculum and daily tasks. The mentor-protégée relationship in school communities has the potential to improve teaching and learning across teaching communities because collegial relationships can foster ongoing trust, support, and development. Administrators often select exceptional teachers to foster mentoring relationships due to their potential to model professionalism and sound instructional practices. In essence, teachers with exceptional skills and strategies should be able to teach their peers these techniques. However, the dynamics of the mentor-protégée relationship can actually hinder professional growth due to concerns about advisory responsibilities. This article reflects on challenges in the peer mentoring process and how teacher-leaders can support the development of their peers.

Introduction

Mentoring is a common practice in education, providing apprenticeship opportunities for teachers to learn skills and strategies from more experienced peers. In addition to improving teaching techniques, mentoring serves to develop collegial relationships and respond to teachers' individual needs (Hertzog, 2002). Mentoring relationships also work to build human capacity and attain common goals. For example, cooperating teachers coach and scaffold field experiences until student teachers are prepared to undertake a full teaching load. In addition, many schools have adopted peer mentoring programs to help new teachers become familiar with the culture of the school. Novices look to teacher-leaders for advice on instructional and curricular issues. The boundaries in both of these mentoring relationships are clear since the mentor is seen as having significantly more teaching experience than the protégée. Due to the protégées' inexperience, all involved in the mentoring relationship expect that mistakes will occur and that critical feedback is necessary and appropriate in the learning process (Hawkey, 1997).

Less distinguishable mentoring relationships, however, form between peers trying to adopt new instructional practices, such as a technology-savvy teacher supporting a group of teachers in their creation of computer-intensive lessons. Mentoring in this context can benefit peer growth because teachers have opportunities to obtain onsite, ongoing, and just in time support.

Collegial complexities can also influence this opportunity. In this situation, a younger, less experienced peer may orchestrate the learning of fellow teachers in the community. Although the protégées are less experienced in their technology use, discomfort may arise in the relationship when less experienced mentors critique the work of their more-experienced peers. Without genuine feedback, however, professional growth can stall because teachers are unaware of shortcomings. We need to understand the potential conflicts in peer mentoring relationships of this nature and determine how to avoid or overcome them.

Conflicts in Peer Mentoring

There are several peer-teaching frameworks (e.g., Carr, 1997; Keedy, 1999; Palmer, 1993). Weekend and summer workshops, for instance, often encourage teachers to conduct follow-up professional development for other teachers about instructional or curricular issues. In this setup, teachers are comfortable orchestrating the learning of other teachers when the workshop does not involve peers from their own school. However, workshop settings often are not meaningful because they are decontextualized from the curriculum and environment and fail to address constraints associated with students' learning needs and teachers' instructional needs (Joyce & Showers, 1995). In fact, teachers find that most workshop learning experiences are not immediately useful to their own classroom practices (Fullan & Stiegelbauer, 1991). Although peer mentoring can be used to help overcome these issues, schools face other challenges that involve the professional and personal relationships among peers.

In peer mentoring, for example, teachers are typically not accustomed to orchestrating the growth of their peers. Hoerr (1996) explains:

> Most teachers are not trained to help peers grow professionally, and the vast majority of teachers find this new role uncomfortable at first. On those occasions when discussions in the teachers' lounge focus on education, they typically deal

> with the three C's: children, curriculum, and complaints. Rarely do teachers solicit feedback about their teaching performance from their peers; rarely do they offer help to one another that goes beyond sharing a ditto master or lending a pair of scissors. Teachers are often reluctant to view themselves as "teachers of teachers." (pp. 380-381)

Hence, teachers' collegiality often takes the form of telling stories, sharing ideas, and sharing resources. While these activities may expand a teacher's repertoire, they will not necessarily enhance understanding of instructional strategies.

Differences in beliefs about teaching and learning can confound teachers' support of one another. For example, Manouchehri (2001) found that teachers with different teaching styles, such as teacher-directed versus student-centered, did not provide useful feedback to one another in peer reflection activities. Teachers were asked to observe each other's classes and then discuss their instructional practices with one another. Although the point of the exercise was to critique constructively their peers' lessons or inquire about different pedagogical techniques, the teachers discussed very little because they believed that peers simply had their own teaching styles. In fact, the observations strengthened teachers' beliefs in their existing practices rather than increasing receptivity to alternatives.

The tendency to respond to teachers' expressed needs instead of monitoring them also hinders collegial interaction. Teachers feel comfortable orchestrating learning in their own classrooms and asking their students to complete specific tasks by certain deadlines. However, among colleagues, many teachers view professional learning as an individual responsibility where teachers ask for help only when they need it (Zahorik, 1987). Thus, mentors take a support role to provide assistance and advice when approached by another teacher, rather than proactively facilitating peer learning. Since teachers are professionals, it is presumed that they regulate their learning or seek learning opportunities when they have free time or critical needs. However, teachers will not likely prioritize their ongoing learning needs due to the abundance of tasks and responsibilities in a school day.

Potential conflicts stem from mentor's dual role as teacher and supervisor. Teachers are accustomed to the requirements and expectations of administrators, but not typically from each other. Consequently, some mentors feel like “a boss” when they ask peers to address a requirement or meet with them to discuss their learning. However, mentors are simply other teachers in the same department or grade level and thus often wish to be viewed as peers. Given the association of a mentor with an administrator, some teachers are uncomfortable speaking frankly about their challenges (Smylie & Denny, 1990). Teachers value the opportunity to share stories, admit mistakes, and brainstorm resolutions with one another once they have developed a personal relationship. In an effort to avoid a disruption to interpersonal connections with peers, mentors may avoid assertive responsibilities such as meeting with teachers individually to address their progress and learning (Keedy, 1999).

Orchestrating a Peer Mentoring Program: One Story

The author began a professional development and research effort at an elementary school to help teachers integrate technology into their instructional practices through peer mentoring. This framework, called *Collaborative Apprenticeship* (Glazer & Hannafin, 2003), promotes ongoing, onsite, and just in time support for teachers as they learn to integrate technology into their instructional practices. Peer mentoring within this professional development framework facilitates interactions among peers. For example, mentors model classroom lessons and instructional strategies, collaboratively brainstorm and design lessons, and coach as peers incorporate technology tools within their instructional practices. Other factors, such as available time to meet, the nature of learning activities, frequency of meetings, and the knowledge and skills of the mentors affect the progress of the teachers' growth in Collaborative Apprenticeship. However, in this experience, the author found that the interactions and relationships between two mentors and their peers had considerable impact on the peers' growth.

During a six-month effort, two educators mentored a 10-teacher fifth-grade team formally on a weekly basis and informally as needed. Both mentors were highly respected by their peers and nominated for the Teacher of the Year award in the school. One individual had been a fifth-grade teacher for four years, had several years' experience incorporating technology into her instructional practices, and saw herself as a "lab rat" that enjoyed creating technology-enhanced learning experiences for her students. The other individual, the school's technology coordinator, provided teachers with technology-enhanced seminars, gave ongoing instructional support in classrooms, and used technology regularly as a classroom teacher. Both teachers have had a variety of mentoring experiences, including peer intervention, supporting student teachers, and mentoring teachers who were new to the school.

Throughout the process, the mentors provided teachers with model lessons, gave demonstrations of applicable software, discussed instructional design strategies, provided advice, and helped teachers brainstorm new ideas for their own lessons. Overall, most participating teachers said the program improved their understanding of the use of technology in their instructional practices. However, throughout the effort, the mentors reported reluctance to promote their peers' development on numerous occasions. Mentors cared about their peers' learning, but feared a disruption in a collegial relationship when teachers were not showing progress. Without proactive intervention, many of these teachers fell behind in their application of technology into their teaching when compared with expectations of the mentors and group planning activities. The result was a professional development experience that facilitated collective activities, but with considerable variation in the growth of individual teachers.

At the conclusion of the professional development effort, the mentors were interviewed and asked to address their feelings about the peer mentoring process. One mentor described the challenge of supporting the development of other peers:

> I think I have had to take my patience a step further, and I think it was a good learning experience for me learning how to convey ideas and instructions to my peers. I think especially because there were a couple of people I had been working with that had been teaching for quite a bit longer than me. So, it's real interesting to teach a veteran teacher something new. It's a different kind of experience, but I think it was beneficial to me. I think I learned a lot about being a teacher to a teacher.

In the past, mentoring involved supporting the development of less experienced teachers, so providing critical feedback was integrated into these processes. With more veteran teachers, the mentors were less direct in their peer feedback for fear of breaking collegial boundaries. For example, to avoid individual confrontation, mentors used a public forum to ask their peers questions and provide feedback. . As one mentor explained: "I do feel it is more intimidating for a couple of them to do it face to face with them. If I go up to them and initiate a conversation, it puts them on the spot…. I feel like it is taken, from their point of view, as if I am checking up on them. I didn't get that feeling when we met together [as a group]…. I don't think they felt as much pressure." However, the mentors also admitted that indirect feedback was not necessarily the best mechanism to enhance peers learning, occasionally giving positive reinforcement to teachers who created activities in need of improvement.

The primary concern of mentors was to avoid saying anything that would jeopardize the collegial relationship. One mentor admitted her awkward position in giving feedback to peers:

> I don't think I gave them as much feedback as I could have at the time. But it's a hard line to walk. You never want to say something to offend anybody, because you would like to work with them (sic). You would never want to say anything that would make them think you thought little of their ability.

However, at the same time, the mentors were aware that several teachers were not progressing. Professional respect among the teachers presumed they would seek help when needed. As one mentor described, "I feel like I should allow people to be flexible enough to say, 'This is when I need help.' Part of it was probably trying to respect them and not assume that they didn't know things." The lack of teacher assertiveness fostered uncertainty in the mentor:

> They are not coming to me as I assumed a couple of people would to get help. I don't know if I haven't made them feel that that was an option. I have said that to

> them, but I don't know if they are not needing help, or if they don't know what to ask.

However, the mentor voiced reluctance about proactively offering help:

> So I guess I have been a little hesitant to push individual meetings with them in a couple of cases when they are probably needing my support. But for me to bring it up, it feels that they are being defensive; [they think they need to tell me] what they haven't done instead of telling me what they are working on.

The mentor concluded:

> That's probably one of the weakest roles I have as far as fulfilling my role, is knowing how to intervene in that process and say, 'Come on, let's get rolling.' …. I'm not sure how to resolve this one, but I know that it is a problem.

The mentors' hesitation to confront their colleagues could have been influenced by several factors, including their lack of interest to be perceived as an authority figure (Smylie & Denny, 1990). Alternatively, some researchers have reported that communication patterns among some women tend to be less direct in nature (Belenky, Clinchy, Goldberger, & Tarule, 1997). If so, perhaps alternative means of mentor-peer communication might be appropriate.

The cognitive dissonance mentors reported affected the teachers' professional development progress. Professional growth was jeopardized when teachers were not given feedback likely to improve their work. Instead of receiving constructive mentor support and feedback, teachers had to learn from their own mistakes by implementing and refining. However, teachers often recognize when they are not improving, and the lack of progress can be frustrating; teachers may abandon innovative practices if they do not have sufficient and successful experiences (Schrum, 1999). As a result, teachers progressed at different rates, even when the mentors cultivated collective professional activities. Thus, it is critical to determine and use mentoring strategies that will stimulate opportunities for ongoing professional growth without jeopardizing collegial boundaries.

Recommendations for Peer Mentoring

The professional growth from peer mentoring can be improved by using strategies that strengthen teachers' relationships. According to MacArthur et al. (1995), relationships between mentor and protégée "are at the heart of the entire mentoring process" (p. 52). Focusing on building and enhancing the connection between teachers helps mentors to overcome their concern about creating discomfort among their colleagues.

One strategy mentors can use to strengthen a peer relationship is to make a concerted effort to understand their protégés on a personal level, making both more comfortable discussing challenging issues. At one point during the study, one of the teachers had not met a minimal school requirement to use the computer laboratory. One mentor reflected on the importance of casual conversation prior to discussion of professional issues. She remarked:

> It kind of gives you an 'in' to go talk to someone if you know what they have been doing in their life away from school, instead of going in and just saying 'Can I talk to you about technology?' For this reason, mentors should strive to build interpersonal relationships if they want to increase their chances at improving the professional growth of a peer.

Develop goals and expectations together should also enhance professional relationships. In typical professional development activities, facilitators establish the agenda and learning goals. In such settings, teachers have neither voice nor investment in the direction of their learning, which may decrease their interest if the activities are not aligned with their needs (Hargreaves, 1994). Mentors can overcome this obstacle by collaboratively developing goals, ideas, and expectations of the learning community with their peers while planning professional development activities. As a group, all teachers can discuss how they would like to learn, support one another, receive feedback, and monitor their development. Once they have a voice, teachers are jointly invested in the activities, understand the expectations, and feel comfortable engaging in interactions that focus on improvement, such as giving or receiving constructive criticism.

Mentors can also build professional relationships by engaging in mutual tasks (McCotter, 2001). For example, a mentor can share with teachers a lesson that has been created by an external source, and then collaboratively address how it can be improved. In this circumstance, mentors and peer teachers familiarize themselves with constructive and professional feedback unlikely to be perceived as harsh or personal by a peer teacher. Mentors can then facilitate collective and individual feedback once the learning community is comfortable addressing a lesson's strengths, weaknesses, and potential improvements.

In addition to providing feedback, mentors can build their professional relationship with their peers by collaboratively designing lesson activities. The mutual engagement process conveys a partnership between mentor and peer, instead of “testing” the peer’s knowledge and skills. In addition, the collaboration helps novice teachers develop instructional strategies from a more experienced peer through modeling, coaching, and continual feedback. In return, peers develop new ideas and strategies in their learning, which also enhances their mentor's teaching repertoire, thus supporting a mutually beneficial partnership (Beyene, Marjorie, & Sanchez, 2002).

Finally, efforts to promote reflection help to strengthen professional relationships between mentors and their peers. Mentors are often concerned about intimidating or offending peers when they remark on a peer teacher’s work. Mentors can alleviate this worry by encouraging teachers to reflect continuously on their own practices (Schon, 1987). For example, mentors can ask teachers questions about the strengths, weaknesses, and potential revisions in a lesson they recently implemented. Mentors may also encourage teachers to keep an ongoing journal of their activities to remain continually reflective about and conscious of their development. Reflection allows teachers an opportunity to think about their practices and devise their own strategies for improvement.

Conclusions: A Researcher's Reflection

The peer mentoring issues discussed in this article evolved from a research effort focusing on teachers’ professional learning during their school day. Research in authentic school contexts is both rewarding and challenging; its greatest reward is observing its usefulness to teachers and student learning, while the primary drawback is relinquishing control by adapting to the limitations and realities of the school environment. In everyday school settings, “stuff” happens; both researchers and study participants should expect a few bumps in the road on their journey.

In this research, a strong community of teachers was selected for participation, but half of them left the school before the study began. Consequently, the strong collegial interactions needed for peer mentoring was challenged from the outset. In addition, during planning meetings about technology, teachers occasionally shifted topics as their pressing needs dictated. In fact, technology applications were rarely discussed during several meetings in order to address and resolve more immediate concerns. The most unanticipated challenge related to teachers' development, however, was the mentors' concern about their relationship with their peers. They felt comfortable orchestrating professional development activities, but uncomfortable working with peers individually due to the shift in presumed authority. These unexpected events actually benefited the research process because they provided opportunity to closely examine pragmatic conditions of schools and to bridge theory to practice. School-based research promotes reflection and strategies for improvement, an outcome beneficial for both research and practice communities.

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EPILOGUE

The purpose of this epilogue is to reflect on the research and writing experiences encountered while completing this dissertation. I examine my learning, perceptions, and contributions in the research process to help me understand where I can have greatest impact in my career. In particular, I discuss the research process in schools, the development of research skills, the alternative dissertation format, the impact of this research, and my future role in education.

Research in Schools

Initially I felt confident the data collection procedures and teacher activities would be in close alignment with the original plan outlined in my prospectus. I met with the teacher-leaders prior to implementation and collaboratively created a timeline for data collection and strategies to support teachers' learning and development. The teacher-leaders were well respected within the school and used technology effectively in their classrooms, so I felt comfortable in their potential to lead the teachers through the professional development effort effectively and efficiently. Due to their strong qualifications, I expected the data collection and professional development process to run smoothly; I did not anticipate challenges they would have with supporting the development of their peers and revisions they would need in scheduling to support the learning needs of their peers.

Contrary to my original expectations, I have learned that conducting research in the school context can be a messy process. Like classroom teaching, this school-based research experience required both pragmatism and flexibility. Control of the environment and its participants' actions was relinquished because research was conducted in *their* school environment. Teachers made decisions based on their motivation, capabilities, and limitations. As a result, while participant contributions were seldom predictable; their actions provided a realistic account of interactions and factors that occur in a situated professional learning environment. For example, teachers often cited limitations of the environment as a factor that impeded their growth. Further, mentors did not promote peer growth as anticipated due to concern over collegial breakdowns. Hence, the research helped me to understand that situated teacher development can be a slow, evolving process.

Flexibility is critical in school-based research. Cancelled meetings, lack of motivation, and prolonged implementation impeded peer-teachers' development of technology-enhanced lessons. Consequently, teacher-leaders' responsiveness to peer-teachers' learning needs became critical in order to sustain teacher participation. Extending the timeline to complete lessons was an important strategy used by teacher-leaders to provide peer-teachers a comfortable environment for professional learning. The additional time gave teacher-leaders greater flexibility to provide onsite, ongoing, and 'just in time' support to their peers using Collaborative Apprenticeship.

As a researcher, I also needed to be flexible with the teacher-leaders' implementation of Collaborative Apprenticeship. The teacher-leaders used five more weeks than anticipated to complete the introduction phase of the professional development effort. Following the original schedule may have deterred teachers' involvement, especially if they did not feel prepared for more collaborative tasks in the developmental phase. The extended time maintained teachers' participation throughout the study, and hence provided opportunities to collect data during different phases of teachers' development. Ongoing data collection was important because I was concerned with the interactions during the evolution of teachers' development. Responding to the pragmatic conditions of the school environment and exploring *how* teachers could design eight technology-intensive lessons was more important than determining *if* they could accomplish this goal under specified conditions. Hence, flexibility is an important component that needs to be incorporated with my future research in school contexts.

Development of Research Skills

Prior to the study, I felt prepared to tackle this research effort based on the skills I had developed in research courses and during my pilot study. I had experience writing field notes and conducting interviews through past research efforts, but to a lesser degree than required in the current study. I needed to coordinate teams of participants and researchers in this research. In past research experiences, I was responsible for implementing an intervention, and now had to support others in their implementation.

I developed and expanded a variety of research skills through this dissertation. First, I strengthened various research methods through extended participation -- 16 hours of interviewing, 20 hours of observations, 65 pages of journaling, and 2200 coded chunks of information. The 90-minute drive each way to and from the field over six months offered opportunities to instantly reflect on experiences and capture them on audio recorder. This was a valuable tool to think about critical questions, concerns and successes about participants, upcoming procedures, and preliminary assertions.

Forming a doctoral research group was another valuable part of the research process. I formed a research group for two reasons: 1) to improve credibility and trustworthiness of data by discussing and cross-checking data, and 2) to provide peers in my department an opportunity to be involved in a research process. The group was helpful in evaluating information, such as criteria for codes, and offering alternative interpretations to data. In addition, inconsistencies in coding often prompted me to discuss data with the group because members were not involved in the data collection process. The clarification and reflection during these discussions often enhanced consistency in the interpretation and consequently strengthened the analysis.

Group member consistency and participation were challenging issues to coordinating the research group. Team members often had scheduling conflicts, which prevented their contribution to the discussions. However, they often provided me coded data and interpretations when they were absent. They still contributed to my work, but I was concerned that I did not contribute to their development because they were not part of the discussions. Scheduling different meeting times sometimes increased involvement, especially when I provided lunch. Another approach to increase participation in future research efforts is to plan individual meetings with group participants so I can respond to their individual learning needs. In future research efforts, I will continue to involve a team to discuss issues surrounding data collection and analysis. The process not only strengthens credibility of the findings, but also engages a community of researchers in collective activities.

The Alternative Dissertation Format

I enjoyed presenting my theoretical framework, research findings, and implications as papers in a journal ready format. The format has provided me an opportunity to disseminate my work quickly to a variety of audiences - researchers, teacher educators, technology coordinators, and teacher-leaders. I valued my committee's support and advice to promote an alternative and applicable framework that can be useful to audiences beyond the researcher and participants.

The actual process of placing my work in this format was more challenging than anticipated. Initially, I wrote my theoretical framework, methods, and findings chapters similar to the traditional dissertation format. However, the chapters were too long for journal publication and were thus divided into separate papers. This process was challenging because I could not simply divide the chapter content equally. Instead, I had to reformulate the concepts to address specific audiences, rewrite several sections, and return to the literature to identify sources that correspond to the various additions. The practitioner pieces, in particular, were challenging because they involved strategies to address implementation problems from, and implications of, the research.

Impact

Throughout this process, I pondered over who may benefit from this research. I realize it has greatly contributed to my development, but alone that would not suffice to support the development and provide opportunities to teachers and researchers. Primarily, I wanted to foster the growth of the fifth grade teachers at the school in which I conducted my research. In some ways, I provided guidance by supporting teacher-leaders and introducing a framework to integrate technology. However, I wanted to be more involved in the mentoring process, especially on occasions when teachers were not successful. I felt my increased involvement as a mentor could have helped the teachers overcome their challenges. It is quite pretentious to think I would be a stronger mentor than the teacher-leaders, but it became difficult not to assist some peer-teachers proactively when they appeared discouraged or unmotivated.

I grappled with my role as a researcher and teacher educator. I wore the hat of a researcher more than a teacher educator because I was trying to capture data relevant to a particular phenomenon. However, I wanted to wear the teacher educator hat, especially in cases where I did not respond to teachers' needs directly. Teacher-leader reflection was one strategy I used to support teachers' needs indirectly. Teacher-leaders wrote bi-weekly journals to reflect on their peers' understanding and future support they could provide. This form of reflection, however, did not encourage teacher-leaders to formulate strategies that would address the concerns they had about some peer-teachers' development. Thus, my intervention with teacher-leaders using reflective discussions periodically was necessary to help the community of teachers move closer to their goal of designing a set of technology-enhanced lessons. Due to my involvement in facilitating occasional reflective discussions, I have concern that technology integration with Collaborative Apprenticeship will not be effective at this school without the continued involvement of a researcher or school leader to orchestrate the reflection process.

Ideally, I hope my work influences the practices of researchers, teacher educators, teachers, and technology coordinators. Realistically, however, I am unsure whether that will happen as a result of this research. I intend to publish six articles from the dissertation and hope that various stakeholders will read and find use for them. This publication record will certainly benefit my own agenda for promotion and tenure, but I wonder if it will help improve others' professional pursuits. I believe this experience has also helped my graduate student peers understand the inquiry and process of research through their participation on the research team. However, I wonder if it will be a stimulus for their continued growth, reflection, and interest in education research. I hope their experiences on the research team impact their future growth.

When reflecting on the impact of an experience, I try to think how other people have impacted my career, like the members of my dissertation committee. I have valued the shared experiences, mentoring, and feedback through relationships more so than their writing (not to say that I do not value their writing). There are *some* pieces of literature that have informed my work, such as Lave and Wenger, but not nearly as much as the relationships of those people who have supported me in my learning and development. Hence, I am not sure if my six journal articles will impact others as much as they have impacted my own development and promotion. However, I do believe the alternative format promotes more opportunities for greater impact than the standard format.

Future

The research process has helped me to reflect on my future contributions to technology integration and innovative learning in school systems. First, in order to understand the professional needs of teachers and support their development, my work needs to be situated in schools as either a participating member of the school community or the context of my inquiry. Considering the teachers' development was influenced by my involvement, I am uncertain whether Collaborative Apprenticeship can be effectively implemented without intervention from a person who is aware of the issues affecting the mentoring relationships and peer-teachers' development of strategies and skills to design technology-enhanced lessons. Without intentional reflection sections with mentors, the nature of teacher activities during planning would not likely have changed. I need to work closely with educational system leaders that are willing to orchestrate reflection and are aware of the teachers' development. If that is not possible, then I need to assume those responsibilities in research, and maybe in practice.

Prior to my defense, I gave about half a dozen presentations about my research at conferences and interviews. At the end of the presentation, I posed a question central to the study: *How do we provide teachers a comfortable environment to support their learning?* Comfort—with technology tools, technology in the classroom, instructional design, taking risks, and with each other— influenced teachers' growth in this study. During each of these presentations, one of the first two responses from participants (researchers, teachers, and administrators) focused on school leadership. They helped me to realize that school leadership, even through small support gestures, may help teachers overcome many of the limitations observed in this research study. I need to explore this avenue further, not only in my research, but also in my professional endeavors.

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APPENDICES

Appendix A

Pilot Study

From A Caterpillar To A Butterfly:

The Growth Of A Teacher In Developing Technology-Enhanced Mathematical Investigations[15]

[15] Glazer, E. M. Submitted to *Technology and Teacher Education*, 12/21/2002.

Abstract

This paper describes the critical experiences of a middle school mathematics teacher as she progressed from a novice to a knowledgeable creator of technology-enhanced learning activities for her classroom. During an eight week intervention, cognitive apprenticeship strategies (Collins, 1991) were utilized in a partnership with the teacher until she felt empowered to independently create these activities without further coaching or support. Qualitative research methods were used to determine the primary factors that lead to such empowerment, as well as the instructional and learning values that the teacher promoted in the activities. This research effort demonstrated that autonomy, confidence, and awareness were prevalent characteristics shown with successful design, development, and implementation of technology-enhanced learning activities. In addition, the teacher's creation of activities was influenced by the teacher's learning values associated with challenging inquiry and continual improvement. Implications from this research effort examine the conditions and support needed to diffuse learned strategies among a community of teachers for broader development and implementation of technology-enhanced learning activities.

Introduction

Inadequate training, insufficient human and physical resources, and resistance to change are critical factors that have created disillusionment about the prospects of technology use among many teachers (Cafolla & Knee, 1995). While technology training is sometimes available, many teachers do not have confidence that the skills and experiences they acquire will be easily transferable to classroom instruction (Marcinkiewicz, 1991). These sentiments indicate that initial professional development is insufficient for learners' needs. Some educators claim that teachers need up to five years of technology experience to reach a point where they can integrate technology effectively within their instruction (Sheingold & Hadley, 1990). In addition, others contend that educators must be given follow up assistance for professional development including peer coaching and department level planning (Sterns, 1991).

Rationale

Byrom's review of literature about technology integration in educational programs (1997) revealed that teachers require ongoing pedagogical and technological support. Byrom indicated that schools with successful technology integration programs provide continual training on-site and just in time. The financial demands of such training can potentially be unrealistic unless pragmatic constraints are considered to support this type of integration effort. Collins' (1991) cognitive apprenticeship model provides such an opportunity, encouraging peer teachers to act as modelers and coaches of technology applications aimed at improving instruction. Since instructional strategies in developing technology-enhanced material are often complex in natural school settings, a cognitive apprenticeship model appears to be a more applicable means of technology integration than traditional apprenticeship that promotes mastery of skills (Cash, et al., 1996). Furthermore, a cognitive apprenticeship model promotes the use of a variety of technologies because the learner develops as a more holistic thinker that utilizes general strategies in the learning and reflection process (Collins, 1991). Several studies in university courses with preservice and inservice teachers have used the cognitive apprenticeship model as a means to support and enhance technology training (Cash et al., 1996; Chyung et al., 1997; Snyder, Farrell, & Baker, 2000). However, a limited number has examined the effectiveness of the model in the situated context of a K-12 school (Browne & Ritchie, 1991), the location where technology applications are put into practice.

The cognitive apprenticeship model is grounded in principles of situated learning and legitimate peripheral participation (Lave & Wenger, 1991), where learning experiences take stronger meaning through activities, contexts, and cultures in apprentice-like situations in naturalistic settings. Contributions and development of novices are legitimized through participation in different roles that gradually assume more responsibility. Learning occurs through social interactions, where individuals use language and communication as a primary means to extend thinking (Vygotsky, 1978).

Problem Statement and Purpose

Teachers participating in a professional development program called InterMath learn mathematics in the context of problem solving with technology. During a 15-week Intermath-experience, teachers use a variety of different cognitive tools in their investigations, such as dynamic geometry, spreadsheets, and function graphers. Even though the teachers become familiar with the tools and the experience of learning mathematics in a technology-enhanced setting, they may not necessarily leave the workshop feeling prepared to design, develop, and implement similar activities geared for students in their classroom. Consequently, some teachers need to obtain additional support so they can independently implement technology-enhanced mathematical investigations in their own classroom.

The goal of this study was to use a cognitive apprenticeship model (Collins, 1991) to support a teacher who had completed a course with InterMath materials in her technology-integration efforts until she could independently design, develop, and implement technology-enhanced mathematical investigations in her classroom. Cognitive apprenticeship is similar to traditional forms of apprenticeship where an expert works closely with an apprentice by providing support and guidance until the novice is self-sufficient. Yet, this form of apprenticeship is uniquely different because it focuses on the learner's capacity to develop heuristics to handle complex situations, instead of learning skills to complete various procedures. This aspect of cognitive apprenticeship is especially important in technology integration efforts, because the teacher needs to consider how technology can be effectively used while balancing a variety of factors, including curriculum, software, resources, time, and students' learning.

The purpose of the study was to examine the factors that influenced a teacher to feel empowered to integrate technology in accordance with the design of investigations and learning environment in the InterMath experience. The research questions that will be addressed in this paper are:

- What factors influenced a teacher to feel empowered to integrate technology according to the methods and design of the InterMath experience?

- What instructional and learning values does a teacher incorporate in the design, development, and implementation of technology-enhanced learning environments?

Description of Technology Training

InterMath

InterMath is a NSF-funded, Internet-based project with the goal of designing and implementing a series of workshops and ongoing support programs that feature contemporary applications of technology and mathematics pedagogy in the middle-grades. The five-year research and development initiative from a collaboration of universities in the state of Georgia was intended to deepen the mathematical understanding of middle school mathematics teachers.

Rationale. The rationale behind InterMath is to encourage changes in teaching and learning with the influence of technology and standards. The pedagogical shifts embodied in a series of documents published by the National Council of Teachers of Mathematics (NCTM) emphasize vastly different approaches to mathematics teaching and learning than are typical in today's classrooms (NCTM, 2000). Rather than static knowledge and skills detached from both other domains and everyday events, mathematics is viewed as problem solving, reasoning, and communicating so that students are empowered to confidently "explore, conjecture, and reason logically [about the world around them]" (NCTM, 1989, p.5). This change in learning philosophy reflects a need for mathematics that is based in an information-rich and technology-based society. Learning goals should incorporate values that reflect mathematics for life, mathematics as a part of cultural heritage, mathematics for the workplace, and mathematics for the scientific and technical community (NCTM, 2000).

Technology and Design. Technology tools and instructional design strategies in InterMath become a mechanism to help instill these values. Technology is used to deliver the curriculum (i.e., Web-based materials) and to explore the mathematics through software such as Geometer's SketchPad (a dynamic geometry software), spreadsheets, and graphing calculators. Mathematical investigations have been designed to promote problem solving in a manner so that:

1. Multiple cases can be investigated using technology.
2. Pre-Algebra students rely on technology to investigate the situation.
3. The investigation promotes generalizability or can be used as a springboard for further exploration.
4. Multiple methods can be used to explore the situation.
5. Multiple solutions are possible.
6. The investigation, based on middle school mathematics, is easy to start exploring.
7. The investigation can be modified for use in a middle school classroom.

Teachers explore the investigations individually and in teams, choosing those which relate to the concepts that they teach, those which utilize technological tools familiar to them, and those which extend their mathematical thinking. Since middle school teachers have varied backgrounds, technical skills, and mathematical understandings, the teachers in the InterMath workshops select a variety of mathematical investigations. At any given time, teachers can be exploring investigations centered around a common theme, such as fractions, but looking at a range of different problems on the InterMath website. In essence, the teachers engage in a curriculum with common principles and topics, but in varied pathways to accommodate to their own learning needs. Teachers share their development and understanding by problem solving and in discussions during class, as well as by developing a webpage to illustrate their detailed work.

Post-Training. Following their problem solving experience as learners of InterMath investigations, teachers develop their own materials for use with middle school students. Since the InterMath investigations are targeted to address middle school concepts, the teachers are provided with a variety of models to support their development of instructional materials. In general, teachers develop their own activities or variations of the InterMath investigations so that they are addressing their own students' learning needs. The teachers are then encouraged to incorporate the following strategies when designing activities for their students:

1. The situation should be loosely-structured and not previously investigated by the students.
2. The situation should encourage students to use technology to explore mathematics.
3. The situation is intended to elicit or deepen conceptual understanding.
4. The situation can be extended for further exploration.

These strategies, along with their learning experiences from exploring investigations on the InterMath website, provide teachers a reference of how learning with technology tools can help stimulate an environment for problem solving in their classrooms.

Methodology

Design

Qualitative research methods were used by the author as the researcher because the questions could be answered by description and interpretation. In essence, the questions "are not framed by operationalizing variables; rather, they are formulated to investigate topics in all their complexity, in context" (Bogdan & Biklen, 1998, p. 2). A case study approach was used based on the nature of the research problem, purpose, and questions. The examination investigated the experiences of one teacher in a single school, thus implying a case as a "phenomenon of some sort occurring in a bounded context" (Miles & Huberman, 1994, p. 25).

Research Participant

Sally Johnson[16] is a 6th grade middle school mathematics and science teacher in her third year at Herrock Middle School in suburban Atlanta. Prior to her participation in InterMath, Ms. Johnson had limited use of technology in the context of teaching and learning mathematics. Ms. Johnson was selected as a participant in this research because she had a formal opportunity to interact with the investigations on InterMath (http://www.intermath-uga.gatech.edu). She participated in InterMath based on her interest to learn more about how technology can support mathematical thinking, as well as the opportunity to earn credit towards a master's degree in mathematics education. Following the InterMath experience and prior to the study, Ms. Johnson had not been integrating technology into her instructional practices. While the course expanded her own understanding of technology tools and how they can be used to support her own mathematical thinking, the instructional and design practices modeled in the InterMath course were not sufficient for her to create similar types of activities for her classroom. The teacher felt that she needed more learning and design experiences that were applicable to *her* students in *her* environment, which would require a re-examination of curriculum, resources, and scaffolding of the lesson. This challenge seemed

[16] Both participant and school names are pseudonyms to protect confidentiality.

overwhelming to undertake individually, however she expressed high interest to explore these avenues knowing that she would be working under direct consultation of an expert. Consequently, the researcher contacted Ms. Johnson near the end of her InterMath course, with the intent to examine the support that was needed to help her apply the learning experiences from InterMath into her classroom the following semester.

Data Collection

Observations, interviews, and archival review were methods used by the researcher to collect data in this study.

Observations. The researcher made observational field notes in the teacher's classroom for almost every technology-enhanced activity created. The notes were transcribed and expanded later in the day, making careful attention to critical moments or areas that needed more clarity. These placeholders in the field notes gave rise for further elaboration after continued discussion with the teacher.

Interviews. After implementation of each technology-enhanced activity in her classroom, the researcher interviewed the teacher for 20 to 40 minutes about the experience at the end of the school day. Interviews were recorded and transcribed verbatim. Semi-structured interview questions (see appendix) were used as a guideline to help the teacher reflect on the experience, and probing questions were included to highlight critical or influential moments more in detail. If the teacher or the researcher was not available to interview after the school day, the teacher responded to the reflection questions over email within the next few days.

Artifacts. Archival documents in the form of teacher essays and lesson plans from InterMath were collected to examine the teacher's conceptual understanding of the mathematical topics she was teaching. In addition, the teacher's technology-enhanced instructional materials were reviewed from initial design to final product in order to capture changes in how she planned to facilitate learning among her students. Teacher emails, researcher journal reflections, and document drafts and feedback of these activities were a means of capturing her learning process through the instructional design.

Researcher's Role

Data collection began two months after Ms. Johnson had completed her university course that utilized the InterMath materials. The researcher established an expert-novice partnership with Ms. Johnson with the intent to help her integrate technology into her classroom practices in light of the learning principles employed in InterMath. The researcher served as an expert in this relationship based on five years of design and development work of technology-enhanced activities as a classroom teacher, as well as continued study of this area working towards a PhD in Instructional Technology. Ms. Johnson, the teacher, was initially a novice at designing activities of this nature, and her experience was based on her understanding from InterMath.

The researcher served as a participant-observer throughout the study. During the first two weeks of the study, the researcher was actively involved in both the design and development of technology-enhanced activities, as well as provided support to students in Ms. Johnson's classroom. As Ms. Johnson's technology integration strategies, the researcher's participation in design, development, and implementation gradually faded until the researcher was primarily an observer during the last two weeks of the study.

The design and development of lessons occurred through one-on-one planning meetings. The meetings examined how the potential activity related to the curriculum, incorporated instructional strategies and problem posing to scaffold and stimulate students' thinking, and utilized technology to enhance students' learning opportunities. Implementation was in the school lab where each of the students had their own computer to use. Six activities were created and implemented in an eight-week time period.

Data Analysis

Analysis was inductive, allowing themes to emerge from constant comparative analysis techniques (Creswell, 1998). Interviews and field notes were coded and clustered into categories based on themes present in the data. In other words, the patterns in the data determined the emergent themes. These patterns were developed based on the representation of codes along with the researcher's intuition, in accordance with the researcher's theoretical framework and the researcher's understanding of the context. The formulation of categories provided an opportunity to make preliminary assertions to reexamine as the analysis and study progresses. Data analysis was continuous throughout the study, occurring during and following data collection. The meaning behind each category and assertion was checked with existing data, and then reevaluated with new data. Once all data were coded, categories were clustered into broader themes, serving as the topics to make larger assertions and findings. Once larger assertions were made, they were shared, validated, and revised through a member check. This process involved sharing written conclusions with the participant, inviting affirmations, additional support, refutations, and alternative ideas. Upon reading the findings, Ms. Johnson agreed with the researcher's remarks and often added additional evidence to strengthen these claims. Her comments were incorporated within the data and included in the findings.

Operational Use of Cognitive Apprenticeship

The following phases of cognitive apprenticeship were initiated by the researcher in this study to promote the teacher's development of strategies to integrate technology into her instructional practices, as well as classroom lessons that employed these strategies.

Modeling. Initially, the researcher developed a technology-enhanced activity, in consultation with the teacher, that supported her instructional goals. The researcher shared strategies and guidelines used to create and implement the activity. As a learner, Ms. Johnson built a conceptual model of creating and using such activities through observation, discussion, and minimal participation in the design process for the first two weeks.

Coaching and Fading. Over the next six weeks, the researcher encouraged the teacher to gradually take more responsibility in the design and implementation of subsequent activities. Coaching techniques such as ongoing questioning, observation, guidance, and feedback provided opportunities to promote reflection and self-awareness within the teacher's development in this phase. Throughout this time period, the researcher's role gradually faded until the teacher was autonomously making instructional design decisions. The fading progression was determined through the teacher's journal, and a discussion between research and teacher following each lesson. In the journal, the teacher responded to the question, "How would you like to plan the next technology-enhanced activity?" as a way to gauge her readiness. In the discussion, the researcher used the teacher's response and a summary of her previous contributions as a mechanism to encourage her continued development.

Scaffolding. Throughout the duration of the study, the teacher and researcher negotiated a structure to design activities that aligned with her curricular and instructional goals. The purpose was to provide support to the teacher as she attempted to integrate technology, while being sensitive to her needs as a novice. The process included establishing learning goals, designing student tasks and questions, creating a technology-enhanced environment to support those goals, assisting with tasks needing help, refining tasks and questions based on limitations within the environment, editing, and providing feedback.

Articulation. The teacher became primarily responsible for the design and implementation of the classroom activities. Experiencing this process enabled the teacher to explain and demonstrate her understanding of the design, development, and implementation process through participation. After implementation, the researcher clarified misconceptions by helping the teacher become self-reflective, or by giving direct feedback. Consequently, the teacher was capable of distinguishing different instructional methods that she would use with different technologies. In addition, upon reflection of these experiences, the teacher made revisions and refinements for subsequent lessons.

Reflection. The reflection process offered the teacher an opportunity to think about improving the design, development, and implementation efforts through successive iterations. It was intended to promote self-awareness so that the teacher was conscious of her actions and to think about the processes involved in her design and instruction. The reflective examination of her work allowed her to suggest ideas for revision and improvement of the learning activity. Reflection occurred through journal writing, email conversations, and informal and planned discussions. Formal teacher reflections followed each activity through interviews or email correspondence, and were structured around questions about successes of the activity, areas for improvement, and responsibilities in the design and development of the next activity.

Exploration. The teacher extended her understanding of instructional strategies to investigate novel and innovative uses, and how to best use technology to support learning in her classroom. The teacher was encouraged to be creative and exploratory so she could make discoveries on her own. In addition, the researcher helped her set goals around how she would continue learning, such as examining new software or creating activities with a different instructional focus. She also set goals regarding what she wanted to accomplish, such as designing a particular activity or collaborating with other peers.

Findings – Broader Themes

Needs awareness, autonomy, and confidence are three primary components that have influenced the teacher in this study to design, develop, and implement technology-enhanced activities, while participation and reflection are primary actions that helped the teacher experience and reveal these themes. Figure A.1 illustrates that the three components connect to one another as represented by vertices of a triangle, and the actions inside the triangle serve as critical experiences that foster these connections. While these themes are not independent from one another, each will be discussed briefly to highlight the factors found in the first research question.

Insert Figure A.1 Here

Needs Awareness

The teacher became aware of her needs to successfully integrate technology. One need she identified was a desire to understand the different features and capabilities of the tools or software. As the teacher learned more with the dynamic geometry tool, she realized that she could improve her design and increase student opportunities with these types of activities. In the design of her activities, she gradually developed more ideas using the software as she gained experience. However, she felt limited with her design capabilities when using a new tool, such as spreadsheets, as noted in her interview:

> I was pleased with some of the problems that I came up with, but then I felt frustrated because those problems limited me …. I only know how to do certain things in Excel … I think that I need some exposure to some different capabilities of that software program.

Another awareness factor the teacher realized was the need for a support community that could help answer questions about different capabilities of the tools. The teacher noted that she had found a network of teachers, faculty, and peers at the university where she could obtain help either in class or by email. She also expressed a need to contact peer teachers in her local community who were also trying to implement similar activities in their classrooms, after stating:

> I have wondered if Dr. Larnick knows any middle school teachers in the county that he would recommend that are on the level with what I am doing. I would like to interact with anyone that seems to be doing these types of things in the classroom so we could talk and learn from each other …. There is a group of

> middle school teachers in our county I have heard about who are doing similar things. I wonder what they are doing in their classroom.

Hence, the awareness theme addresses both learning and support issues that were needed to improve her development of instructional materials.

Autonomy

The teacher demonstrated that she could independently design, develop, and implement technology-enhanced mathematical investigations in her classroom. Initially, the researcher modeled the design process involving consultation with the teacher, and after the fourth cycle of design (out of the six), the management and authorship was reversed. In fact, the researcher was completely removed from the field environment when the teacher felt that she had developed one of her best activities. In her reflections, the teacher reported, "I think the class went very well. Definitely the best yet. I could really see the progress the students have made. They were able to do more on their own, and I noticed growth in their responses and explanations."

The teacher also felt that she had become capable of preparing other teachers to design and implement technology-enhanced investigations, assuming that she has a support network (not necessarily in her school) where she could ask questions and raise ideas. When asked if she felt ready to mentor another teacher in designing activities, she noted:

> Oh yeah, but I think we would run into the wall a lot…. And I know that I could probably do it. I've got lots of people I could email and I'll be taking classes next year, so it will be real easy to ask somebody in class, "Well, how do you this, or what about this?" I think that we are going to have places where we get stuck, but

> I think that I've got some of those capabilities that a lot of people don't have access to normally.

At the time of this study, Ms. Johnson was assigned to teach seventh grade math the following school year, a content area that she has not taught before. Even though she would be facing many changes, Ms. Johnson felt comfortable in making this transition because she would have an opportunity to not only learn from other teachers, but also share her design skills to develop technology-enhanced activities with her new team.

<u>Confidence</u>

This teacher attributed her growth in confidence in using the technology as a factor that promoted her willingness to integrate these activities. Her confidence was influenced by her increased use and application of the tools. While the InterMath course provided an avenue for Ms. Johnson to learn how to use different technology tools, her confidence did not grow until she could apply her understanding in a classroom context. A critical moment occurred during a lesson when a student recognized an error in one of the templates. Ms. Johnson had accidentally saved the wrong file to the server and the students could not progress because of a missing button on the template. Ms. Johnson independently modified the necessary modifications to the template and then placed the revised version of the file on the server. She then asked the class to replace their current file with the new one that she had just saved. Upon reflection of this experience, the teacher recognized that she had overcome anxiety to use the software when she stated:

> I felt more confident in myself as a teacher of technology that I was able to handle the problem when I realized the "Triple" sketch did not have a show/hide button. One of the things that intimidates teachers new to this type of learning is the fear

> that something like that will happen and you won't know what to do. I think I lost a lot of that fear.

The teacher also realized that any type of problem can occur in her classroom, such as the power failing, so she felt that she did not need to have to constantly worry that something might go wrong because problems are natural and inevitable. More important to the teacher was having confidence that she could problem-solve and troubleshoot as problems arise.

Another example of the teacher's confidence was her ability to independently extend the integration process in a new setting. The teacher decided to use the computer as a presentation tool to prepare students for classroom investigations that would occur the next day, and then summarize findings the following day. She noted that she would even spontaneously use the computer as a demonstration tool in her classroom when she felt it would help students better understand a concept. She noted:

> That's been really interesting to me, because before I could have never pictured myself doing that. I don't know if you had told me at the beginning of this school year that I would be achieving the types of things I have been trying to achieve with them…it's one thing to go in on the Internet and show them how to get to something, or show them how to do something, but we're…actually creating the template together. It didn't take but a few minutes, but I had to be able to do it while I was conducting class, and I had to be able to build from their input and reflect on that.

Thus, the development of this teacher's confidence to use technology tools became a prominent factor that related to her successful integration of technology-enhanced activities. She became comfortable enough to create learning templates when a teachable moment arose in an effort to enable her students to explore algebraic patterns in a spreadsheet or properties of shapes in dynamic geometry software.

Reflection

Reflection helped this teacher increase her needs awareness, autonomy, and confidence. Interviews and email correspondence following each activity helped the teacher think about what she had learned from the experience, as well as what she would do differently next time. As the reflection process continued throughout the study, the teacher became more aware of her upcoming reflections and consequently became more conscious of her actions in the classroom. In essence, she became a continuously reflecting practitioner because her self-reflection became habitual to the extent that she did not need any prompting.

The teacher commented that being "forced" to make reflections helped her reach this understanding, as she stated:

> Had I just been teaching my classes and going about my day, I might have thought about it as I was driving to class that night, but I wouldn't have actually focused in on it. Where I think that really writing and discussing some conclusions helps me realize some good points, and I think that even just knowing questions that you are going to ask has made me much more observant as to what is going on in the classroom.

Hence, reflection was a critical experience that attributed to her ongoing development because she was able to actively recognize her progress and areas of needed improvement.

Participation

Participating in this experience helped the teacher realize her needs awareness, autonomy, and confidence. She validated ideas from theory and research when she saw them in practice, when noting, "You can read and hear and see all of those things all you want, but I've never actually seen it where it's been brought to my attention, and oh wow, look what they are doing." Ms. Johnson conveyed her frustration with a colleague in her school who was enrolled in the InterMath workshop during the time of this study. Ms. Johnson felt that this teacher was not benefiting from the experience and commented in her interview:

> Basically, it's like they [the students] really can do these things because I am doing them. Come let me show you what they are doing because they are really doing these things…[I know] it's really hard to see, especially at the sixth grade level…for me, it was hard to see how this could be toned down to a sixth grade level, but not watered down that it took away from what it was doing. And that's a challenge. But once you can see how it could be done, and you start getting the hang of it, then it could really be done. They're really learning from it.

Through the cognitive apprenticeship model, the teacher in this study was able to be a legitimate participant in a situated setting throughout the entire research experience, at first in a peripheral role, and then later in a central role. This participation has influenced her growth and development as a teacher and integrator of technology-enhanced mathematical investigations.

Findings – Emergent Perspectives

While this study was aimed at finding general themes that related to one teacher's autonomous use and design of technology-enhanced activities, the teacher's motivation and rationale to continue creating technology-enhanced activities became an integral component in her development. The teacher's learning style, scaffolding of students' learning, ongoing evaluation of her materials, continual improvement in student learning, and attention to enhancing the learning experience were dominant components in her development of activities.

Incorporating Learning Style

The teacher wanted her students' learning to resemble her preferred learning style of exploration with little guidance. Her work from the InterMath workshop was based on exploring patterns with a dynamic template on the computer, making conjectures, and rationalizing the argument with an explanation of the patterns or a mathematical proof. Ms. Johnson also demonstrated this learning style when she developed templates for her student activities. Throughout the design and development process, Ms. Johnson emphasized that she would like to determine how to create the template on her own with as little guidance as possible. If she had difficulty in her design, she would continue exploring and consider alternative avenues before seeking assistance.

In her classroom, the teacher would encourage the same type of thinking and learning among her students. The activities were filled with questions that had students hypothesize a result to a scenario, and then confirm it through experimentation and forming a mathematical argument. As students had questions, Ms. Johnson did not answer them directly. Instead, she encouraged students to think about alternative ways to look at the problem, as well as how the students could help each other. It was very unusual if the teacher responded to student questions with answers. The teacher felt she could help the students push their thinking by continuing to question their understanding . For example, when a group of students thought they had obtained a correct answer, they asked the teacher to validate the accuracy in their conclusion. Instead of telling the students that they were correct or incorrect, she asked them if they had tested multiple cases involving the same pattern, or if they had examined alternative shapes to check their hypothesis. In addition, she had asked the students if they had checked their solution with other teams to see if there was consensus or disagreement with their methods and response.

<u>Scaffolding of Students' Learning</u>

The teacher wanted her activities to have limited scaffolding, enough for students to feel comfortable but not so much that she guided them to the answer. The teacher posed problems that required students to use multiple steps in their reasoning, but did not provide them with hints or clues on their activity sheets. Instead, she had students think over the questions during class and provided them assistance as it was needed. She mentioned,

> I would think if they don't struggle a little bit with it, then I am providing too much guidance because …. If it doesn't make you a little bit uncomfortable or something, then you're not learning anything. So, I think that there should be a little bit of struggle with it, and especially at this level and at this age because they are not used to someone not telling them what to do and how to do it.

Hence, the structure that the teacher promoted through these learning activities became an active and ongoing focus of her attention because she wanted her students to engage in problem solving experiences. She felt that the limited guidance encouraged students to be more independent in their thinking. Interestingly, the structure for student learning in her activities parallels the scaffolding she desired when she learned to design the activities. In order to facilitate this type of learning environment, the teacher designed investigations that promoted the use of technology tools, such as spreadsheets and dynamic geometry. The use of tools-driven software enabled Ms. Johnson to create questions with limited scaffolding that promoted inquiry, investigation, and exploration, with the intent *not* to guide students to predetermined answers.

Ongoing Evaluation of Materials

The teacher used a variety of sources to evaluate her materials with a goal of understanding how they could be improved. Ms. Johnson would share her work with the researcher each time she developed an idea and a draft of an activity. Ideas were generated prior to planning meetings, discussed during the meetings, and lesson generation and feedback were provided electronically. In addition, she would share the activities with her colleagues at school and seek feedback. In general, though, she found the feedback from her peers not very helpful because it was not very critical or reflective. Instead, Ms. Johnson reported that she typically received positive feedback without constructive criticism from her peers because they were impressed that she was trying something innovative. The teacher also used her students as another source to evaluate her work. Prior to the activity, she would ask some of the students what they thought of certain questions or to test out a template that she had made, taking note of their difficulties and questions. Finally, the teacher continually evaluated her work through reflection. In addition to emails and interviews, she would often report thinking about the changes she would make during her 30-minute car rides to and from our meetings. Ultimately, she felt that her ongoing reflection made her conscious of making revisions even during her instruction when she felt that it was needed.

Continual Improvement in Student Learning

The teacher was motivated to continue developing technology-enhanced materials based on the success of her students. When she first began asking open-ended questions, she was disappointed to see that the students were not giving thoughtful responses but just short answers without much explanation. After a discussion with her students and assessment of the students' work, Ms. Johnson discovered that the students were giving these types of responses because they had not been familiar with these types of questions. In addition, she learned that the students were anxious about completing all of the questions because they wanted to receive full credit for their work. Once she told the students that she was more concerned with their reasoning than completeness, she was impressed with the students that showed gradual improvement in the quality of their explanations. Ms. Johnson noted:

> I think that I have become very proud...I don't know if that's the right word, [It's] not what I'm doing, but what they're [the students] doing there. I have been much more observant of different types of peer interactions and learning and things like that that are going on. That's been much more rewarding for me than seeing tests that I took home to grade...just hearing them think, their thought process. You know, I've seen them move closer to where I want them to be. Being able to see

> that has really shown me how much they've learned and how much they are getting out of doing that.

The teacher reported that her interest in her students' improvement was a critical factor that influenced her motivation to continue developing instructional materials. Her willingness to put forth effort to create instructional materials beyond her additional teaching responsibilities was influenced by identifying changes in her students' learning progress.

Attention to Enhancing the Learning Experience

In the design, development, and implementation of an activity, Ms. Johnson was carefully attuned to how the experience could enhance learning through problem solving and deepening the understanding of a concept. When planning an activity, she first closely examined if and how an idea could be closely tied to curricular objectives so that the learning experience could be connected to the concepts discussed in her class. On the activity sheet and in class, the teacher posed questions that encouraged students to engage in problem solving and explain their reasoning. The questions focused on using the technology as a tool for visualizing and computing so they could attend to making and testing conjectures. One investigation she created for the students was:

> Your employer has put you in charge of the packaging for a new promotional item. If children send in 10 proofs of purchase along with $1.95 to cover shipping, they will receive a box of 125 cubic centimeters of SLIME! The packaging for the slime should be in the shape of a rectangular prism for easy mailing. What dimensions should you give this package?

With the question, students were given a computer template of a rectangular prism with fixed volume of 125 cubic centimeters. The prism was dynamic, meaning that students were able to modify the dimensions of the prism and still maintain a constant volume in the package. In many middle-school textbook problem-solving investigations, students are often given numbers or measurements that they will need to solve the problem. However, in this case, students needed to determine what concepts and parts of the prism they would like to measure since there were not any existing clues. Hence, incorporating an unmeasured diagram was an instructional design strategy that the teacher employed as a technique to encourage students to think about a situation conceptually before applying algorithms. Once students identified the applicable concept, they needed to use the technology to investigate how the surface area of the prism changes with its dimensions. Since the tool is dynamic, students could see instant changes in calculations on the screen as dimensions changed. Upon hypothesizing the dimensions of an ideal package, the teacher embraced them with the simple, yet critical question, *Why?* In other words, why does this particular output on the screen produce the best conditions for packaging? While the technology provides a stimulus for students to fluidly model multiple cases of a prism and hypothesize the result to this problem, the teacher's effort to have students explain *why* their result is true brought greater meaning to the students' understanding of the solution.

Implications

The findings in the study are limited to this particular case. However, the experiences revealed raise implications for further research and practice. Instead of addressing knowledge and skills that teachers need to acquire, the implications focus on understanding and promoting teachers as ongoing learners so they can propel each others' learning within their professional community.

Future Research

Implementation of the cognitive apprenticeship model needs to be extended to a community of teachers. Through this research, a teacher became more autonomous in her design and development of technology-enhanced activities. The next step toward the development of such a community might be the transition of Ms. Johnson from teacher to peer coach. However, the expertise and experiences required of such a leader are ill-defined in technology integration literature. Simply being more knowledgeable or experienced than her colleagues does not guarantee that a teacher would be able to develop and extend other teachers' use of technology within instructional settings. Thus, research is needed to examine the factors needed to mentor teachers—initiative, preparation, and success with implementation— to implement a cognitive apprenticeship model among a community of teachers. Furthermore, research is needed to better understand how leadership and teacher attributes influence the success of the cognitive apprenticeship experience—for both mentor and apprentice.

The role and potential of reciprocity in teaching communities also warrants additional study. Examination of the cognitive apprenticeship model may not be as important as understanding how teachers provide support to their peers. While individual teachers may vary in their technology integration practices, the collective wisdom of the community of teachers draws upon a far vaster set of experiences concerning curriculum and instructional strategies. Different combinations of cognitive, behavioral, or environmental factors may stimulate interactions among a community of teachers that promote peer support. Efforts to promote reciprocal interactions among a professional community may elicit qualitatively and quantitatively different learning and development compared to non-professional communities.

Suggestions for Practice

Educators must address the culture and organization of schools in order to provide opportunities for teachers to engage in ongoing professional development and reciprocal interactions in the context of their teaching, such as providing a centralized teacher office and common planning periods. Even if the teacher in this study felt compelled to collaborate and help extend the technology integration strategies of her peers, she needed an environment to facilitate learning among peers. Few teachers have adequate preparation or collegial time to develop as a community. Rather, "planning time" is provided as segmented blocks of time that are rarely aligned with colleagues who teach the same subjects or grade levels (Hargreaves, 1994). Without shared time and practice, professional development becomes an experience outside of the school day, unconnected to classroom practice (Hord, 1997). This decontextualization can be detrimental to both becoming proficient in technology integration and to the evolution of a sustainable, supportive community of professional teachers.

Conclusions

Technology training can fall short of its goal to enhance student learning if the teacher's learning experiences are limited to a university classroom or professional development workshop. In this study, a teacher who successfully learned to use a variety of technology tools in a workshop setting still needed additional support to concretize their applicability to her students' learning. Subsequently, a cognitive apprenticeship model was used to extend classroom learning in order to support a teacher until she could independently design, develop, and implement technology-enhanced mathematical investigations in her classroom. Autonomy, needs awareness, and confidence were three prevalent characteristics demonstrated by the teacher as she reached this goal. Ongoing participation and reflection were critical experiences that propelled the teacher's growth to design, develop, and implement technology-enhanced activities. Creation of the activities were sustained through cognitive apprenticeship, but was also influenced by the teacher's values about her instructional practices. The teacher's learning style, scaffolding of students' learning, ongoing evaluation of her materials, continual improvement in student learning, and attention to enhancing the learning experience were dominant components in her development of technology-enhanced activities.

At the end of eight weeks, this teacher continued to design activities, felt confident to teach her peers what she learned, and found a network of colleagues at the university to continually help and learn. The semester following the study, she took initiative in her school to mentor other teachers in their use of technology in their classrooms. Hence, this relationship was a catalyst for technology integration in her professional community.

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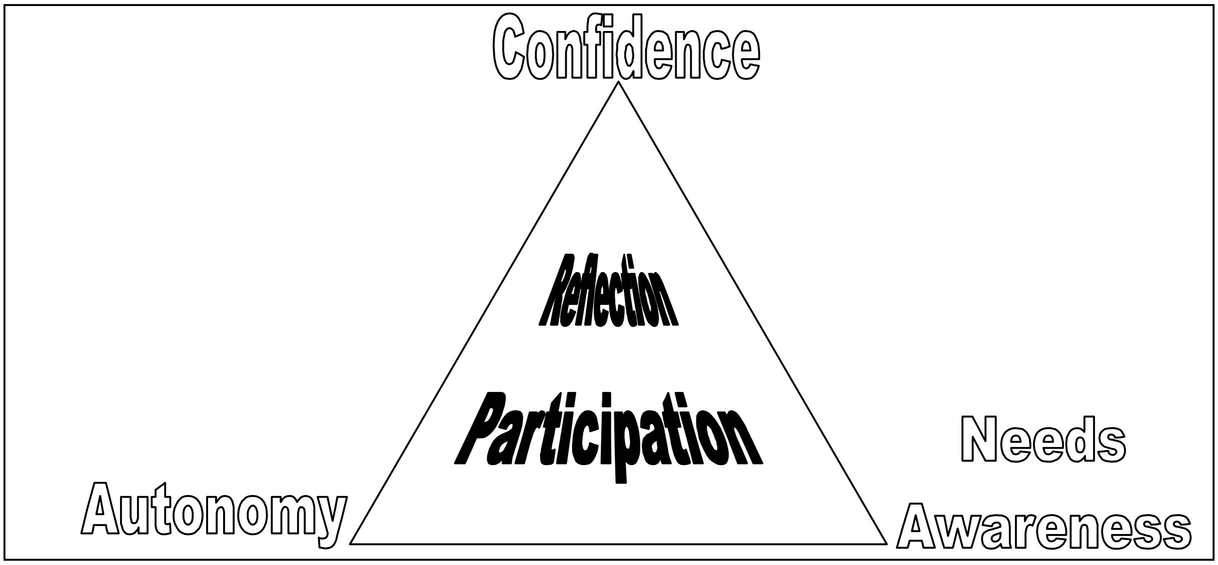

Figure A.1. Factors that influenced the teacher's success in designing technology-enhanced learning materials.

Appendix

Interview Questions Following Implementation of a Technology-Enhanced Activity

1. How do you think the class went?

2. What did you like most about the activity?

3. What do you think the students enjoyed most about the activity?

4. Describe the learning you noticed throughout the class period. Is it what you expected?

5. If you had to do this activity again, what would you change in the lesson?

6. How would you like to plan the next technology-enhanced activity?

Appendix B

Timeline Of Use Of Collaborative Apprenticeship Model

Number of Weeks	Technology Integration Phase	Teacher-leader Roles	Peer-teacher Roles	Collaborative Partnership	Activities Completed
Eight	Introduction	Promotes and models use of technology in workshop or classroom environments	Observes and participates in learning applications of technology	Discuss and reflect on learning and design experience	Three
Seven	Developmental	Provides scaffolding, coaching and fading to design, develop, and implement learning activities	Acquires software and design skills in context of participation	Collaboratively design, develop, and implement technology-enhanced learning activities	Three
Eight	Proficient	Identifies areas for improvement and exploration	Articulates understanding by autonomously designing activities	Share experience and ideas with peer community	Two
Not completed in study – assessment in post-intervention interview	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	NA

Appendix C

Data Sources Used To Address Research Questions

Research Question	Critical Data Sources
1. What factors support or hinder reciprocal interactions among a community of teachers when a collaborative apprenticeship model is implemented?	1. Observational field notes, informal interviews, teacher-leader journals, peer-teacher reflections, post-interview
2. What interactions help support or hinder a community of teachers as they attempt to integrate technology in their classrooms?	2. Observational field notes, informal interviews, peer-teacher reflections, teacher-leader journals, post-interview
3. How might interactions and factors relate to the growth of teachers as they incorporate technology into their instructional practices?	3. Observational field notes, pre-interview, post-interview, teacher-leader journals, structured reflective sessions, researcher reflective journal
4. How does the perceived role of the teacher-leaders affect the interactions and professional development of their peers?	4. Post-interview, teacher-leader journals, structured reflective sessions, researcher reflective journal

Appendix D

Interview Questions Prior To Use Of Collaborative Apprenticeship Model

The interview protocol prior to the study was guided by the following questions.

- What technology tools have you learned to use that is helpful in your teaching?

    Follow up questions can include:

    - How have you used these tools in your teaching?
    - If so, what type of instructional or technical support have you needed? If not, explain.

- Describe to me an experience where you have received help or learned from another teacher in your department.

    Follow up questions can include:

    - What types of interactions occurred between you and this individual or group during this process?
    - What factors might influence your interest to interact with a colleague? Explain.
    - Do you feel that experience improved your understanding or teaching? Explain.
    - Do you feel that experience motivated you to continue learning? Explain.

- Describe to me an experience where you have given help to or taught another teacher in your department.

    Follow up questions can include:

    - What types of interactions occurred between you and this individual or group during this process?
    - What factors might influence your interest to interact with a colleague? Explain.

- Do you feel that experience improved your, or your colleague's, understanding or teaching? Explain.
- Do you feel that experience motivated you to continue helping? Explain.

Additional probing questions were asked throughout the interview to help participants elaborate on their experiences.

Appendix E

Protocol For Informal Interviews

I informally interviewed teachers at moments when they wanted to talk to me about their concerns, interests, successes, and failures, or when I wanted to seek clarification about an observation or teacher reflection. These interviews were not planned, typically short, and occurred at any time or place. They were intended to respond to the needs of the teacher, as well as my own, in an effort to seek deeper understanding and resolution.

During an informal interview, I carefully listened to the teacher's comments. I purposefully avoided giving advice or my perceptions, unless requested. These interviews were not recorded. When possible, I jotted down a few main ideas during the interview. At the earliest possible moment following the interview, I wrote down the content of the informal interview, and then provided preliminary interpretations in the margin of my notes.

Appendix F

Reflection Sessions With Teacher-Leaders

On three occasions, the researcher facilitated a 30-45 minute reflection session with teacher-leaders. The researcher requested a reflection session with the teacher-leaders if it appeared that the peer-teachers were not advancing their skills and strategies to integrate technology. The purpose of the reflection session was to help teacher-leaders think about their peers learning and development, and have them develop strategies to work towards a common goal. The teacher-leaders' goal for this project was for their peer-teachers to independently design and develop technology-enhanced lessons by the end of the semester. The researcher used the following questions to structure each reflection session:

- How do you think everything is going?
- What strategies can you take to move your peers closer to the goal?
- How will you use those strategies in the next few planning meetings?

The researcher asked probing questions on occasion, but allowed most of the interaction to occur between the two teacher-leaders.

Appendix G

Interview Questions Following Study

The interview protocol following the study was guided by the following questions.

- What did you think about your use of technology this semester?

  Follow up question can include:

  - What have you learned?
  - What do you still need to learn?
  - Do you feel comfortable helping your peers when they have technology related questions? Explain.
  - Do you think you could be a mentor next semester? Explain.
- How have your colleagues helped, or not helped, you as you created technology-enhanced activities?

  Follow up question can include:

  - What types of interactions between you and your colleagues were helpful in your learning?
  - What factors may have influenced your colleagues' willingness to help?
- How have you helped, or not helped, your colleagues as you created technology-enhanced activities?

  Follow up question can include:

  - What types of interactions between you and your colleagues were helpful in your learning?
  - What factors may have influenced your willingness to help?

Additional probing questions were asked throughout the interview to help participants elaborate on their experiences.

Appendix H

Reflection Statements Following Implementation

Teachers were asked to write reflections after each experience of integrating technology. These reflections were guided by the questions

- What did you like about the activity?
- What did you dislike about the activity?
- How have interactions with colleagues helped you create this activity? What else would have been helpful? Please give specific instances.
- How would you like to be involved in creating the next activity that uses technology?

The first two questions were intended to help the teacher reflect on the design of the activity, as well as his or her own values about learning with technology. The third question was a means to record reciprocal interactions, and the fourth question related to use of the collaborative apprenticeship model.

Appendix I

Bi-Weekly Journals Of Teacher-Leaders

Teacher-leaders kept ongoing bi-weekly journals reflecting the development of their peer-teachers. These journal reflections were guided by the questions:

- What phase are you in the collaborative apprenticeship model?
- What responsibilities do you have in designing, developing, and implementing the current technology-enhanced activity?
- What responsibilities do the peer-teachers have in designing, developing, and implementing the current technology-enhanced activity? Please discuss each teacher's involvement.
- How have interactions, or lack of interactions, with colleagues affected their learning and development efforts? Please give specific instances.
- What responsibilities would you like between you and the peer-teachers in designing, developing, and implementing the next activity? In other words, how much extra responsibility should the peer-teachers assume for the development of the next activity?

The first and fifth questions relate to use of the collaborative apprenticeship model. The second and third questions were intended to help the teacher-leader reflect on the design of the activity, as well as the development and contributions of her peers. The fourth question was a means to record reciprocal interactions.

Appendix J

Timeline Of Procedures

Procedure	Persons Involved	Activities	Date
Describe collaborative apprenticeship with teacher-leaders	Teacher-leaders and researcher	Review collaborative apprenticeship model; discuss research design and responsibilities; review roles in existing mentor model	March 2002
Describe collaborative apprenticeship with department	Grade level teachers and researcher	Review collaborative apprenticeship model; discuss research design; create shared goals and expectations	April 2002
Collaboratively design, develop, and implement technology-enhanced instructional materials	Teacher-leaders and researcher	Practice design that reflects how the activity relates to the curriculum, incorporates instructional strategies and problem posing to scaffold and stimulate students' thinking, and utilizes technology to enhance students' learning opportunities.	April 2002
Interview teachers about technology experience and situated professional development	All participants and researcher, one-on-one	Interview that reflects the teacher's understanding and use of technology, and how they support their peers' learning and development (see Appendix D for protocol)	August 2002
Primary Data Analysis	Researcher	Transcribe interviews and planning meetings. Analyze data through iterative cycles (constant comparison).	September 2002-February 2003
Collaborative Apprenticeship – Introduction Phase	Teacher-leaders and peer-teachers	See Appendix K for procedures	Weeks 1-8 of Fall 2002 semester
Collaborative Apprenticeship - Developmental Phase	Teacher-leaders and peer-teachers	See Appendix K for procedures	Weeks 9-15 of Fall 2002 semester

Collaborative Apprenticeship – Proficient Phase	Teacher-leaders and peer-teachers	See Appendix K for procedures	Weeks 16-23 of Fall 2002 semester, Spring 2003 semester
Interview teachers about semester experience	All participants and researcher, one-on-one	Interview that reflects the teacher's understanding and use of technology, and how they support their peers' learning and development (see Appendix G for protocol)	February 2003
Member check to validate data	All participants and researcher	Ask participants to review summarized findings, and give feedback for validations and suggested revisions	March 2003
Present Findings	Researcher	Complete articles for dissertation	March-April 2003

Appendix K

Operational Procedures Of Collaborative Apprenticeship Model As Implemented By Teacher-Leaders

Week	Technology Integration Phase	Teacher-leader Actions	Peer-teacher Actions	Interaction Mechanisms
1	Introduction	Demonstrate first technology-enhanced classroom activity to peer-teachers (social studies - westward expansion).	Learn about and discuss activity, and implement it in classroom	Weekly meeting
2	Introduction	Demonstrate second technology-enhanced classroom activity to peer-teachers (science - coral reef). Continued discussion of first activity.	Learn about and discuss activity, and implement it in classroom	Weekly meeting
3	Introduction	Continued discussion of first activity. Discussion of implementing basic-skills program (non-technology related).	Implement one of first two activities in classroom.	Weekly meeting
4	Introduction	Discussion of different software available to teachers, and how they connect to the curriculum.	Implement one of first two activities in classroom, and explore different available software.	Weekly meeting
5	Introduction	Demonstrate the software *Inspiration* and discussion of possible activities with the program in different curricular areas.	Implement one of the activities using *Inspiration* in classroom.	Weekly meeting
6	Introduction	Demonstrate another technology-enhanced classroom activity to peer-teachers (social studies - inventors).	Learn about and discuss activity, possible revisions, and implement it in classroom	Weekly meeting
7	Introduction	Meeting cancelled. The second meeting continues discussion of inventors activity.	Continue classroom implementation	Consultation from teacher-leaders, as needed; Weekly meeting

Week	Technology Integration Phase	Teacher-leader Actions	Peer-teacher Actions	Interaction Mechanisms
8	Introduction	Demonstrate another technology-enhanced classroom activity to peer-teachers (social studies - classroom time machine).	Learn about and discuss activity, and other ideas teachers are thinking about, possible revisions, and implement it in classroom.	Weekly meeting
9	Developmental	Coordinate discussion to develop collaborative activity on immigration. Discuss how to find resources.	Identify resources for collaborative activity on immigration.	Weekly meeting, and informal interactions to respond to inquiries
10	Developmental	Coordinate discussion to develop lesson ideas for immigration day.	Brainstorm ideas in different content areas considering available resources. Begin developing lessons.	Two meetings, and informal interactions to design lessons and respond to inquiries
11	Developmental	Coordinate groups to develop activities for immigration day.	Continue developing lessons in small groups. Explore applicable software as needed.	Weekly meeting with small group interactions.
12	Developmental	Assist peers on use of technology or developing lessons	Implement previous lessons, and begin thinking about new ideas to share.	No meeting. Informal interactions to respond to inquiries
13	Developmental	Assist peers on use of technology or developing lessons	Implement previous lessons, and begin thinking about new ideas to share.	No meeting. Informal interactions to respond to inquiries
14	Developmental	Ask questions about ideas that have been shared to provide feedback.	Share ideas to group.	Weekly meeting, and informal interactions to respond to inquiries

Week	Technology Integration Phase	Teacher-leader Actions	Peer-teacher Actions	Interaction Mechanisms
15	Developmental	Lead hands on exploration of *Math Keys* software in lab.	Learn different features of software. Brainstorm lesson plan ideas	Weekly meeting, and informal interactions to respond to inquiries
16	Proficient	Ask questions about ideas that have been shared to provide feedback.	Discuss two person designed lesson plans.	Weekly meeting, and informal interactions
17	Proficient	Assist peers on use of technology, responding to queries, and provide feedback as needed.	Implement collaborative lesson in classroom. Begin thinking about independent activity.	No meeting. Informal interactions to respond to inquiries
18	Proficient	Assist peers on use of technology, responding to queries, and provide feedback as needed.	Implement collaborative lesson in classroom. Begin thinking about independent activity.	No meeting. Informal interactions to respond to inquiries
19	Proficient	Assist peers on use of technology, responding to queries, and provide feedback as needed.	Implement collaborative lesson in classroom. Begin thinking about independent activity.	No meeting. Informal interactions to respond to inquiries
20	Proficient	Assist peers on use of technology, responding to queries, and provide feedback as needed.	Explore different uses of technology tools, and begin designing original lesson independently.	No meeting. Informal interactions to respond to inquiries
21	Proficient	Assist peers on use of technology, responding to queries, and provide feedback as needed.	Explore different uses of technology tools, and begin designing original lesson independently.	No meeting. Informal interactions to respond to inquiries
22	Proficient	Assist peers on use of technology, responding to queries, and provide feedback as needed.	Complete original lesson independently. Implement in classroom, if applicable.	No meeting. Informal interactions to respond to inquiries
23	Proficient	Facilitate discussion of final activities, organize them, and distribute to community.	Share final activity, and provide reflections.	Weekly meeting

Appendix L

Criteria For Assigning Codes

Code	Category	Description	Example
story telling	reciprocal interaction	A verbal exchange based on a reflection of a teaching and/or learning experience.	Jan tells Kim about how she used the computer in class today.
'backscratching'	reciprocal interaction	An agreement to participate on the condition that it is reciprocated.	Ted tells Deborah that he will try her activity if she will try his.
discussing and resolving conflict	reciprocal interaction	A verbal exchange that raises issues and concerns that have not yet been resolved.	Fred tells Kim that he is not available to show her how to do something on the computer, so they examine other ways in which she can receive help.
brainstorming	reciprocal interaction	A demonstration of insights and thoughts that solicits the opinions of others to generate or explore new ideas or evaluate existing ideas.	Deborah was devising a lesson on triangles, and sought the input from her peers for ideas on how to incorporate technology.
giving and seeking advice	reciprocal interaction	A comment that seeks or offers an opinion or strategy in the design of a lesson or in teaching.	Jeff tells Ted that he thinks it would be a good idea to use the help menu in the computer program if he forgets how to make a map.
modeling	reciprocal interaction	A demonstration that provides an example of how something is performed with the intent that others will replicate the actions or strategies.	Fred presents to the group how to evaluate a word-processed file on the computer so they can do that on their own.
sharing ideas	reciprocal interaction	A verbal exchange of information or display of physical material that is used to provide examples and share experiences.	Kim shows Ted a template that she thought of the other day to use in the next lesson.
motivating and reinforcing	reciprocal interaction	A verbal or physical demonstration of encouragement or acknowledgment with the intent to promote another individual to carry out an action, improve, or receive praise for good work.	Fred gave Ted a 'high five' for successfully using the activity in his class.

Code	Category	Description	Example
posing and responding to task-based questions	reciprocal interaction	A verbal or physical action that involves seeking or providing support or clarification that involves knowledge and skills.	Sam asked Deborah how she could open a new window on the computer. Deborah showed Sam how to do this. Then, Jeff showed both Deborah and Sam a shortcut.
caring	affect factor	A genuine concern about someone else's well-being.	Deborah explained that she was really concerned about Sam's progress.
anxiety level	affect factor	A display of comfort or stress.	Sheila told Mike that she does not how much longer she can handle this job. Consequently, she does not have much of a desire to collaborate with her peers right now.
patience and sensitivity	affect factor	Being compassionate with someone else's needs.	Juan gave Jeff plenty of time to experiment with the computer and ask questions before moving onto a new idea.
enjoyment	affect factor	A sense of appreciation and satisfaction for participating, designing, or helping.	Juanita said that she really liked creating activities that involved technology because her students had great learning experiences at the computer lab.
connection to a group	affect factor	A sense of belonging to a community.	Ted mentioned that he feels comfortable interacting with his team because he is seen as a valued contributor.
friendly climate	affect factor	Demonstrating positive demeanor towards one another.	Sam stated that he really enjoyed coming to school every day to see everyone's smiling faces, and the passion that the teachers' exhibit.

Code	Category	Description	Example
connection to an individual	affect factor	A sense of camaraderie with a peer.	Jen felt that Jerri was a great person to ask questions because they have developed a great relationship over the years.
respect	affect factor	An appreciation of an individual and her opinion for her knowledge, quality of work, leadership, or demeanor.	Roger thinks that learning technology tools is useful because Sally, a very accomplished teacher, says they are beneficial for students' learning.
teaching	beliefs factor	Thoughts about how to teach, how to improve teaching, and alternative teaching methods	Joe remarked that it was a waste of time to talk about cooperative learning because he didn't think that students could learn in groups.
learning	beliefs factor	Thoughts about student and personal learning, how to improve learning, and alternative learning methods	Zoe found it valuable to learn how other people approached the problem.
instructional design	beliefs factor	Thoughts about the factors that affect the creation and contents of a learning activity.	Sue that it was essential to create a notesheet with questions as students use the Internet so they can organize their thinking.
social obligation	beliefs factor	An obligation to contribute to the group's goals and assist peers due to association, commitment, or experience.	Roy felt he needed to take on a leadership role and offer some ideas to the team because he has often valued from peers in similar situations in the past.
self-efficacy	beliefs factor	Perceptions in one's ability to effectively perform, such as completing a task or supporting an individual.	Jan felt that she could not install the software because she thinks she destroys computers whenever she touches them.
proximity	environment factor	Being physically close to another individual.	June remarked that she found it helpful to have Deborah nearby so she could ask questions and get responses quickly.

Code	Category	Description	Example
shared time	environment factor	Having an opportunity to interact with a colleague during the same time.	Joe thought it was a waste of time to spend his planning period once a week with the team when he could have easily used the time to complete the task on his own.
individual time	environment factor	A feeling of having or not having enough time to complete individual tasks in order to create space for shared time.	Deborah expressed there was not enough time in the day to complete her work, and could not afford to stay after school to meet with peers.
human resources (expertise)	environment factor	Having knowledgeable people available to answer individual questions.	Shannon felt confident that she would learn how to design a lesson knowing that she could ask Deborah questions as she needed help.
physical resources	environment factor	Having physical resources, such as technology tools and instructional guides, available to reference and explore.	Colette found it helpful to have the opportunity to independently explore a piece of software on her own time so she could prepare to discuss instructional implications with the group.
accessibility	environment factor	Having or not having access to human or physical resources.	Tara lost motivation to use the computer lab because she felt that she needed to schedule her class in the lab three weeks in advance, which was too inconvenient for her planning.
leadership	culture factor	Providing direction and managing an environment.	Ted thought that Deborah’s ability to coordinate the group’s effort was outstanding.
professionalism	culture factor	Showing respect towards teaching and learning with appropriate attire, demeanor, and language.	Colette did not like talking to Shannon about the lesson because she constantly complained about teachers and students.
curriculum	culture factor	Instructional goals and content used in teaching.	The teachers always looked at the district standards first when planning a lesson together.

Code	Category	Description	Example
mutual responsibility	culture factor	A collaborative effort where all participants are responsible for making contributions to the best of their ability.	Jan noted that Fred's participation in the project was lackluster. As a result, she did not have much of a desire to communicate with him on future activities.
peer feedback	culture factor	Providing avenues for teachers to comment on each other's ideas and work.	Fred explained that giving and receiving comments on the activity was critical towards his development.
shared tasks	culture factor	Providing avenues for teachers to collaborate in their teaching, learning, or designing.	Deborah made an effort to pair teachers up as they generated ideas. She felt they would be more comfortable to interact if they had another person to bounce ideas.
common understanding	cognition factor	Developing a shared perspective about goals or a course of action.	Before using the lab, the teachers discussed how the students should use the computer in the upcoming activity.
priority	cognition factor	Making planning or instructional decisions based on available time and resources.	Ann restructured her schedule to assist Ron because he was troubled with the technology lesson he was planning to use tomorrow.
awareness of learning behaviors	cognition factor	Having or demonstrating an opinion about how people learn.	Deborah felt that it was difficult to approach Zoe for ideas because Zoe seems to be a very private person.
lower-order thinking	cognition factor	Having or not having knowledge, comprehension, or application skills to complete a task.	John felt he could not offer ideas to the group because he still did not know how to use the program.

Code	Category	Description	Example
higher-order thinking	cognition factor	Having uncertainty in a complex situation involving analysis, synthesis, or evaluation.	Fred thought that it was helpful to analyze his instructional challenges with Ann because she could often give a variety of perspectives and solutions.
reflection	cognition factor	Thinking about a past activity, and how it may influence future practices.	Tony felt that it was important to first think about what happened in class before discussing the outcomes with his peers.
assertiveness	personality factor	Actively seeing someone to share an idea or seek assistance.	Tara went over to Deborah's classroom to ask her a question before school because they did not have a common planning time.
motivation	personality factor	Having interest and desire to participate, create, and interact.	Sally said she wanted to design and share more lessons because the positive feedback from her peers made her glad she was helping the team.
responsibility	personality factor	Being accountable for your own learning and development, or other people's learning and development.	Zoe felt that her peers needed to come prepared to the meeting with questions and ideas in order for everyone to value the experience.
autonomy	personality factor	Portraying independence in the design, development, or implementation of an activity.	Sally preferred not to ask for help from Rudy to prove to herself that she can complete the lesson on her own.
availability	personality factor	A willingness to tell others that you can assist when they have questions.	John felt comfortable approaching Sam with questions because she constantly told the group that she would be willing to help anyone at any time.

Code	Category	Description	Example
open-mindedness	personality factor	A willingness to listen to and consider a variety of options before making a decision.	Rudy suspended his judgment about his teaching experience in the lab, and decided to obtain a variety of opinions from his colleagues on other instructional strategies he could have used.
organization	personality factor	Consciously planning and structuring a learning environment with specific order.	Sally thought the communication in the planning meetings was useless; teachers were often off topic since there was not an apparent agenda with an anticipated goal to accomplish.

Appendix M

Preliminary Assertions Related To Coded Categories

Code	Assertion
Accessibility	Mentors and teachers want their peers to feel that they can come to them for assistance at any time. However, due to time constraints, sometimes people are accessible by appointment or during times of urgency.
Accessibility	Teachers would prefer to have greater access to technology and resources, and some feel restricted based on limited access.
Accessibility	Having opportunities to use resources, such as computers or manuals, as they are discussed can solidify the teachers' understanding of a tool or strategy.
Anxiety	Teachers feel overwhelmed with the school day due to their myriad of responsibilities beyond teaching. As a result, they have difficulty focusing on their development, and try not to ask others that appear overwhelmed.
Anxiety	It is difficult for teachers to learn or implement if they do not feel comfortable about their environment or overwhelmed with their responsibilities.
Anxiety	Teachers feel more comfortable with technology-integrated lessons if they have been successfully used in other teachers' classes, have experience using and teaching with the software, have access to resources like manuals, and have access to the technology coordinator.
Anxiety	Teachers feel relieved of planning responsibilities when lessons are shared across the grade level.
Anxiety	The mentors are concerned about approaching teachers individually because it may make the teacher feel uncomfortable. They respect the teacher's privacy, and would prefer that they take the initiative for help.
Assertiveness	Teachers often feel they have to take the initiative and approach people if they want to learn something to help their teaching in an efficient manner.
Assertiveness	Teachers who are not assertive are dependent on the guidance from mentors to extend their development. However, mentors are likely to engage in conversations with assertive people to respond to their need, instead of being conscious of the development of their nonassertive peers.
Autonomy	Teachers like to work at their own pace and have control over the direction of their curriculum.
Autonomy	When the teachers are left to complete some independent work, the mentors do not intervene unless a request for help is made. The mentors prefer that the teachers constantly work towards independence.

Autonomy	If teachers are comfortable with their ability of the technology tool, they will independently try to create a lesson or find resources if they are not given scaffolding.
Availability	Mentors and teachers tell each other that they are available to their peers to provide assistance or give input, yet will only intervene or participate if assistance is requested, their peer is struggling, or their peer has lack of knowledge or skills. Occasionally, they will 'check in' by email or in person to see how things are going.
Awareness of learning behaviors	Some teachers would like their learning scaffolded with examples and modeling, while others prefer to learn from their own mistakes.
Awareness of learning behaviors	Mentors would like the teachers to be aware that their use of technology will require patience to work through some unsuccessful attempts.
Awareness of learning behaviors	The mentors feel that observing another teacher model a lesson is helpful for their learning.
Awareness of learning behaviors	The mentors prefer to be viewed as a peer that helps support their peers learning by providing resources, advice, and helping them build on their strengths.
Awareness of learning behaviors	Some teachers will not pay attention to a large group discussion if they thing the conversation will not be at their learning pace or relevant to their curriculum. Consequently, many teachers like to explore and then obtain one-on-one assistance when needed (customized learning)
Awareness of learning behaviors	Teachers' development can be slowed, if not halted, if the mentors are not conscious of their development. The exception are those teachers with assertive personalities. Consequently, it is valuable to support the mentors in their reflection process, and develop strategies to help them learn about their peers' development.
Awareness of learning behaviors	Mentors will provide more assistance and resources to those teachers that ask questions, have difficulty, or have less experience or familiarity.
Awareness of learning behaviors	Mentors would prefer to provide learning experiences with one-on-one consultations and hands-on use of technology if resources were available. However, the disadvantage to this setting is a concern that the mentors may intimidate the teachers if expectations are not clearly established.
Awareness of learning behaviors	Feedback is often given informally to make it as non-threatening as possible, either in the form of questions in large groups, advice, or modeling desirable strategies in a classroom.
Backscratching	Some teachers complete routine tasks for the grade level to save each other time, like photocopying and calendar making.
Brainstorming	If teachers feel they have thinking time or make the time to think, they have willingness to explore the capabilities of new

	technologies and new instructional ideas.
Brainstorming	In the past, the teachers have not been familiar with group brainstorming sessions. On an individual basis, they will work with colleagues to develop a shared understanding and possible ways to address issues and problems in their classrooms.
Brainstorming	In a group, a mentor will initiate some brainstorming when teachers are looking for ideas or when the shared time is intended for brainstorming. After initial ideas are suggested from the mentor, other teachers often mention more ideas.
Brainstorming	Teachers will view a variety of resources, such as lesson used in the past, lessons online, data, literature, and teacher resource books, to help them brainstorm ideas of what they would like to use in their classroom.
Brainstorming	Brainstorming sessions initiate a process where teachers develop lessons, instead of just implement someone else's lesson.
Caring	Mentors will help teachers sometimes to boost their self-confidence, even if they already know how to use technology tools.
Caring	Teachers will interact with someone for assistance or advice when they find them easy going, nice, and helpful.
Caring	Teachers value mentors that are supporting and critical in their work, sharing good work with others and privately critiquing it for improvement.
Caring	Teachers will 'check in' on each other on a regular basis and are willing to offer help for teachers that are new to the school or seem troubled/overwhelmed with their work.
Caring	Teachers will offer to complete tasks for others if they plan on doing them for themselves.
Common Understanding	Teachers will offer different perspectives to help each other empathize with particular feelings or situations.
Common Understanding	Teachers will discuss their plans if they have a new shared task, such as CQI.
Common Understanding	Teachers will continually ask questions to understand how another teachers uses a tool or instructional strategy in his/her classroom.
Common Understanding	When the teachers are using the computer, the mentor will provide assistance to make sure that all teachers have performed certain tasks.
Common Understanding	Teachers will share ideas is they share the same experience, such as taking a course together, being new to the school, teaching the same class, or coming from a similar background.
Connection to Group	The technology coordinator shares individual teachers' ideas or summarizes group ideas and responsibilities with the entire grade level by sending a group email.
Connection to Group	Teachers learn in group environments, even if they do not have

	questions, because others will ask questions they had not thought of before.
Connection to Group	Teachers feel disconnected from the group when they do not have shared time together. However, they find ways to make this connection by sharing each others' ideas.
Connection to Group	Teachers will come together to share ideas if they have a shared responsibility that has not been resolved. However, if they are together in a group, and do not discuss a shared responsibility, then individual minds wander away from the group discussion.
Connection to Group	It is difficult for teachers to feel connected to the group if they feel uncomfortable in the environment.
Connection to Group	Teachers appreciate their environment more knowing that their ideas are being used by other teachers at the grade level.
Connection to Group	If teachers do not value what is being accomplished or do not feel comfortable to talk in the group setting, they will interact with teachers on an individual basis during the shared time or with teachers outside of the shared time.
Connection to Group	Mentors prefer to give feedback to teachers' work in group meetings in the form of questions so they are non-threatening and non-judgmental.
Connection to Group	Mentors and teachers lose awareness of their peers progress if they do not have regular contact with them (proximity or shared time).
Connection to Group	Teachers complete shared tasks for each other if they plan on doing them themselves.
Connection to Individual	A mentor finds it important to work with a peer as an equal to improve his/her work.
Connection to Individual	Teachers form stronger friendships when they work together on shared tasks, are going through similar experiences, or share similar curriculum.
Connection to Individual	Teachers turn to teachers for advice if they know them on a personal level or they feel they are approachable (and also if they are a mentor/expert and seem to have available time) because they feel comfortable with them to share challenges and failures.
Curriculum	Teachers make instructional decisions based on the AKS district standards and Georgia Quality Core Curriculum. They try to creatively incorporate multiple AKS in their lesson plans, and use resources from the QCC website. They rarely create activities without thinking of how the district standards will fit in.
Curriculum	The CQI requirement limits teachers' flexibility to expand on their curriculum since it reinforces basic skills. Since teachers have this added responsibility, they find it difficulty to create new activities, such as those that incorporate technology.
Curriculum	Teachers will engage in conversations or shared tasks when they teach the same subject. If they do not teach the same subject,

	they often do not contribute to the conversations.
Curriculum	Teachers approach other teachers that do not stick to the book's curriculum since they are looking for ways to expand beyond what the book has to offer.
Curriculum	Mentors prefer to have teachers design lessons that fill curriculum gaps. However, teachers prefer to design lessons that incorporate subjects and topics they feel comfortable and enjoy. If teachers were given more time to explore technologies in areas related to the curriculum gap, with more guidance and support, then their comfort level would increase.
Curriculum	If a mentor does not teach a particular subject, then another grade level leader will step up to this responsibility and try to share ideas.
Curriculum	Teachers will turn to peers to discuss curriculum issues before speaking to the technology coordinator.
Discussing and Resolving Conflict	Teachers try to resolve conflict by helping each other understand multiple points of view.
Discussing and Resolving Conflict	Teachers resolve conflict by helping each other work on their strengths and overcome overwhelming parts of their job.
Discussing and Resolving Conflict	Teachers view resident experts as people they can approach when they need to resolve conflict.
Discussing and Resolving Conflict	Conflict that affects the grade level is initiated in group meetings or by email by a grade level leader. Once the conversation begins, other teachers add more information based on their experience or interpretation.
Discussing and Resolving Conflict	Teachers offer advice based on knowledge or experience to one another in response to another teacher expressing frustration.
Discussing and Resolving Conflict	Teachers feel that less frustration would arise is they were able to work more closely with a more knowledgeable peer.
Enjoyment	Teachers enjoy creating activities if they see the impact it has on their students' learning.
Enjoyment	Teachers do not enjoy creating activities if they are uncomfortable with their learning environment or feel overwhelmed with a variety of other tasks.
Enjoyment	Teachers see progress in their increased use and comfort with technology.
Enjoyment	The mentors are proud of the teachers' progress, considering their challenges and high turnover in staff.
Enjoyment	The technology coordinator enjoys being involved in grade level discussions where she can offer advice and be part of the teachers' planning.
Enjoyment	Teachers will share activities that they feel successful about in their own teaching.
Feedback	Mentors give feedback in group settings in the form of questions as to not threaten the individual teachers receiving the feedback.

Feedback	Feedback is given only when it is solicited from the teachers. The feedback is most often non-critical because the peers believe that teachers have different teaching styles and also don't want to affect their personal relationships. If a teacher does not seek feedback, then she probably won't get it. The mentors feel uncomfortable intervening with teachers, unless it is a last resort.
Feedback	If peers have connection to an individual or a defined mentoring relationship, then they are more receptive to different forms of feedback.
Feedback	Teachers hope that mentors work with them closely, one-on-one, in collaborative forms such as peer teaching or peer designing, to give them feedback.
Friendly Climate	Teachers feel comfortable approaching their peers for assistance if they feel they are easy going.
Friendly Climate	If teachers feel comfortable with their peers, then they like a group forum to speak their mind freely. Otherwise, they will do this on an individual basis.
Giving and Seeking Advice	Teachers ask for advice during informal settings. In group settings, they feel comfortable asking for advice if they have an assertive personality.
Giving and Seeking Advice	Teachers ask for advise from resident experts or more experienced teachers if they are available. The advise is often about instructional strategies, instructional design strategies, and use of resources.
Giving and Seeking Advice	Mentors will give advice to teachers if they appear to be struggling. Otherwise, they wait to be asked for advice before giving it (unless they are leading a discussion to provide strategies).
Giving and Seeking Advice	Teachers give advice on personal experience, and will not give advice if they do not feel they have enough experience. If they feel they cannot give advice, the offer another person to speak with. Mentors handle advice slightly differently by speculating what might happen in the classroom, and then offer advice based on this prediction.
Giving and Seeking Advice	Mentors will offer unsolicited advice if it enhances, but does not critique, the teachers' work, or enhances their understanding. For example, talking about additional resources and features of a software, offering instructional or design strategies following an introduction, or making a webpage look nicer.
Giving and Seeking Advice	Some teachers will not try a new idea or activity unless they seek advice from their peers or a mentor.
Giving and Seeking Advice	Some teachers feel that they are not being asked for advice very much during informal times due to the shared time that has been made to address technology issues.
Higher ordered	Teachers gain ideas by evaluating existing lessons from others

thinking	and then modifying them to suit their classroom needs.
Higher ordered thinking	Teachers examine the utility of software by determining how well its instructional methods and content align with their own teaching style.
Human Resources	Teachers highly value easy access to people with expertise (having knowledge, skills, and experience) where questions can be addressed in an efficient manner (one-to-one basis). If they do not have access to expert persons, they may not ask questions until they see or contact those people.
Human Resources	Teachers value access to people who can explain well.
Human Resources	If they do not have the knowledge or experience, teachers will redirect questions to other teachers who they think have that knowledge or experience.
Human Resources	A teacher developing a lesson often asks peers what they have done in the past for the particular topic.
Human Resources	If time were available, some teachers prefer to learn and find answers on their own before consulting with another person.
Human Resources	Teachers ask questions to people that are near by, people they feel a connection, people who are experienced or have knowledge, and people who are assigned as leaders or mentors.
Human Resources	More mentors at the grade level can help increase the support and development of teachers.
Human Resources	Setting aside a time to discuss issues has provided people with ideas to discuss issues they would not have thought of independently.
Human Resources	Once teachers develop comfort and experience with a tool or strategy, they feel comfortable helping their peers.
Instructional Design	It is easier to design activities in smaller groups, where as more sharing occurs in larger groups.
Instructional Design	Teachers find a resource they like, and then design an activity using the resource (instead of vice versa).
Instructional Design	Mentors give advice, and sometimes models, of what they think should be included in a technology-enhanced activity, but do not guide teachers through the design process to produce a lesson. Instead, ideas are shared and end tasks are assigned in meetings, and the teachers are expected to ask for help from the mentors if they have questions.
Instructional Design	Most of the design and development strategies are proposed by mentors.
Instructional Design	Teachers like to have access to resources when planning to design activities. They gather the resources, and the restructure, rebuild, and revise them for their own purposes.
Instructional Design	Some teachers have been designing more of their own activities under this structure than they have in the past.
Instructional Design	Teachers further in their development have an attitude that their

	work will likely need revision in the future.
Instructional Design	Teachers need models of learning activities that are in alignment with their style of teaching in order to start adopting instructional design methods.
Instructional Design	Teachers further in their development are usually more organized with their instructional planning.
Leadership	Mentors find it more challenging to teach their peers than their students because the teacher-student expectation is not very well-defined.
Leadership	Teachers feel they can take on a leadership role to support their peers' development if they have knowledge, success, and experience. Otherwise, they would be willing to assist, but not necessarily with confidence.
Leadership	Teachers will take on leadership responsibilities if they are the most knowledgeable source based on the people available.
Leadership	Teachers look to their assigned mentors and the grade level chair to discuss issues that relate to the culture of the school.
Leadership	Leaders often provide resources to teachers, such as handouts that they have used in the past or those that they have developed.
Leadership	An increased number of mentors has potential to increase the development of peer teachers due to more one-on-one interactions.
Leadership	Some teachers cannot show their leadership potential due to lack of opportunities for interactions with other teachers.
Learning	Teachers enjoy hands-on learning opportunities, and observations to see something in practice, and expect to receive the same attention for their learning as they do for their students' learning.
Learning	Mentors have learned by reflecting on their interactions and watching the products their peers create.
Learning	Teachers are resistant to learning in formal settings because they have adapted a belief that meetings and staff development are typically unproductive. Instead, during informal settings, they can personalize their learning and make individual requests.
Learning	Teachers have learning styles similar to the way they teacher their classes. More structured teachers would like focused learning activities, and more open-ended teachers prefer to explore independently.
Learning	Some teachers value organized settings because other teachers come up with questions that they hadn't thought of and would find useful.
Learning	Teachers and mentors share strategies to design and implement a lesson based on how students have reacted and learned in the past.
Learning	Teachers believe that their lessons are more successful in the lab over time because the students are more comfortable using the computers.

Learning	Mentors and teachers feel that teachers need to take ownership of their learning in order to develop successfully (teachers need to take initiative and bring ideas and questions to contribute to the group). They are hesitant to push the development of their peers because they don't want to intimidate them. However, maybe asking those teachers questions to reflect on their development may prompt their initiative.
Learning	Some teachers have been more motivated to learn to design technology-enhanced lessons once they see their students' positive learning experiences with lessons of this nature.
Learning	If teachers have initial exposure to a resource or skills, the mentors will spend additional time working with teachers that do not have these skills.
Learning	The mentors ask the teachers about their students' learning difficulties so they can determine what technology resources would be most useful to them.
Learning	Once teachers feel comfortable using the technology resource, they do not interact with peers on the lesson creation until they want feedback on a draft. Essentially, they do not discuss what the lesson will look like and how it will be created.
Learning	Due to their learning experiences, the mentors feel that the new teachers have adopted technology into their instructional practices much more quickly than in the past. The new teachers see it as an expected and natural part of their curriculum, whereas some more experienced teachers see technology use as an add-on, or a different subject.
Learning	The mentors and teachers feel the teachers learning could have been more productive in smaller focus groups that discuss the same curriculum and have a structured agenda based on the interests of the teachers.
Learning	Teachers who have developed more quickly feel that they learn from a variety of resources, and not just resident experts.
Learning	Teachers want learning experiences with some applicable examples, guidance, coaching, and availability to answer questions, until they feel comfortable and confident to develop and implement lessons independently.
Learning	Teachers need to feel comfortable using a technology tool before using it with their classroom. They do not want to face situations where they cannot answer a question or troubleshoot a problem.
Learning	Teachers who have successful development skills realize that they have had to learn from their mistakes in the classroom, that practice helps them be more attuned into preparing for a lesson.
Lower Order Thinking	Teachers ask information and skills-based questions prior to thinking about how it can be used in a classroom setting.
Lower Order	Teachers find it easier to learn (time efficient) from peers when

Thinking	they 'teach' the program to them.
Lower Order Thinking	Teachers often answer lower order thinking questions during moments when there is not much time available. They occur during longer shared time periods, but higher order questions are more likely to occur when longer periods of time are available.
Lower Order Thinking	Teachers who do not have basic understanding of the software have difficulty developing lessons that would use the software. Other teachers, in addition to mentors, provide assistance to those teachers in order to catch them up on their skills.
Modeling	Some teachers learn by watching teachers use a lesson or strategies in their own classroom, or by team teaching. However, this cannot be accomplished with a shared planning time.
Modeling	Some teachers prefer to be shown what to do, and others like steps on how they can do it on their own. Teachers who try it on their own with someone watching feel like they remember it better.
Modeling	Mentors would rather model positive behaviors and strategies with a teacher than discuss areas that need improvement.
Modeling	Mentors use examples to show teachers what is expected in a lesson and also as a guide to discuss strategies. Several teachers desire discussion of the lesson for clarity and then implement it in their classroom for a shared learning experience.
Modeling	The mentors did not work through the design of a specific lesson with teachers, and several felt that this would have helped them in their own development. Instead, the mentors discussed and listed the strategies they use when designing lessons, but did not find a way to make them operational.
Modeling	Mentors introduce different software by providing a guided tour, either as demonstration or hands on, and explain how different features can be incorporated within a lesson(s). The first time a teacher uses a software, they often sign up with the technology coordinator for support or to lead the lesson.
Motivating and Reinforcing	Teachers are encouraging to each other when they feel they are not succeeding.
Motivating and Reinforcing	Teachers tell each other when they have a great idea.
Motivating and Reinforcing	The mentors will often give positive feedback to teachers for just trying something, regardless if it meets their expectations.
Motivating and Reinforcing	The mentors encourage the teachers to share their lessons and ideas with other teachers.
Motivating and Reinforcing	Some teachers find motivation to continue developing lessons when they get positive feedback from their peers, and see the lesson used in their classes.
Motivating and Reinforcing	The mentors give positive feedback for effort and encouragement for self-doubt from the less developed teachers, and for

	achievement and insight from the more developed teachers.
Motivation	Teachers are motivated when the see potential learning opportunities for their students with technology tools.
Motivation	Teachers are motivated to learn if they feel they are working with a good mentor.
Motivation	Teachers are motivated by having greater access to resources.
Motivation	Teachers are not motivated to attend meetings if they have more immediate concerns.
Motivation	Teachers are not motivated to incorporate technology within their teaching if they feel overwhelmed, uncomfortable with technology tools, do not see connections to their curriculum, or do not see how it aligns with their teaching beliefs.
Motivation	Teachers find value in technology use if it makes their job easier, or see that their students learn when using it.
Motivation	If teachers are motivated to do something, then they will make time for it.
Motivation	Successful learners are motivated to be better teachers, and try to incorporate a variety of tools and strategies to help their students get the best possible learning experience.
Mutual Responsibility	Teachers share responsibility for completing tasks that they both intend on using in their classrooms. This can promote collaboration among people who normally don't interact regularly.
Mutual Responsibility	The mentors encourage the teachers to find resources, such as Internet sites, that will enhance their lessons.
Mutual Responsibility	The mentors devised a plan for teachers to work together, but ultimately divided them not by task, but instead by curriculum area.
Open mindedness	Many teachers are open to listening to strategies and ideas that other people use in their classrooms. Even if they have their lessons planned, teachers will still inquire about what others are doing.
Open mindedness	As teachers are less overwhelmed and more comfortable with their environment, they become more open to trying new ideas such as incorporating technology.
Open mindedness	Teachers feel more comfortable to freely speak their thoughts (learn from mistakes) to colleagues they feel comfortable with and are open minded.
Open mindedness	Even when mentors feel that a peer is making a mistake, they encourage them to continue talking to hear all of their reasoning and motives.
Open mindedness	Successful developers and adopters of technology have an open mind to considering new ways to enhance their teaching.
Organization	Teachers prefer meetings to be structured with an agenda that surrounds a shared curricular topic in order to maximize value of

	their time. In addition, some teachers prefer the organization of the 18 weeks to be structured with modeling, followed by individual contributions in different areas of the curriculum
Organization	Teachers are interested in creating a place to store all resources and activities created by teachers.
Organization	Successful developers were organized in their classroom and responded to all journal entries. Some non-successful developers responded to very few journal entries.
Organization	Some teachers believe that professional development during a structured time is difficult because it does not reflect the needs of the individual teacher, and ideas are more difficult to share.
Organization	Some teachers feel they need to get more organized with their classroom instruction before they feel prepared to incorporate other resources, such as technology tools.
patience and sensitivity	Teachers more likely approach their peers that they find easy going (non-intervening) and laid back (admitting that they have also made mistakes).
patience and sensitivity	Teachers understand that others may work at different rates, and thus end up exploring independently with a new computer tool, or helping one of their peers.
patience and sensitivity	Mentors try to understand the learning needs of their peers and try to let them know that it is ok to receive assistance and brainstorm with them.
patience and sensitivity	Several teachers feel that their peers can help them without worrying about the time commitment.
patience and sensitivity	Leaders give their peers an opportunity to make mistakes and learn from them without feeling like they have failed.
patience and sensitivity	Some teachers look out for the well-being of their peers because they want them to feel comfortable with their environment and succeed.
Physical resources	If teachers have time, they enjoy exploring the capabilities of software, and then having human resources available to ask questions. Otherwise, the prefer a manual or have someone explain the software to them.
Physical resources	Teachers will search for lessons on the Internet at the GLC site, and look through professional magazines and past lessons, to gain ideas for their classroom and share with others.
Physical resources	Teachers share Internet sites with the technology coordinator, who in return shares them with the grade level.
Physical resources	Teachers will get so involved exploring with the computer, that some do not interact with their peers even when sitting besides them.
Physical resources	Teachers awareness of resources enables them to feel they have many possibilities to design lessons and use technology in various parts of their curriculum. The successful developers often

	investigate a variety of resources when creating their own lessons.
Physical resources	In joint planning sessions, teachers are asked to find websites and then they are collectively organized by the technology coordinator.
Physical resources	Many teachers are interested in the resources that teachers find external to the book for sharing. They often learn about them by looking at the teachers' hall displays.
Physical resources	Teachers use the content on websites to drive their technology-enhanced lessons.
Physical resources	Teachers connect with each other by sharing printouts of resources and past and new lessons and worksheets within and across groups.
Physical resources	Teachers who do not read their email do not obtain some information because it is not repeated in the group setting.
Physical resources	Teachers often have more questions about the features and functionality of a piece of software than designing a lesson that uses the software.
Physical resources	As teachers brainstorm, they refer to resources that can be used, such as websites, videos, and books.
posing and responding to task based questions	Teachers often ask for support from a peer in helping them complete an operation on the computer that is preventing them from completing a task.
posing and responding to task based questions	Teachers like to have support available nearby to ask questions.
posing and responding to task based questions	Teachers appreciate those people who are always willing to answer questions, or be willing to explore together to find an answer.
posing and responding to task based questions	New teachers ask many questions to their mentors about logistics and procedures in the school. They also ask the technology coordinator questions relating to lab use and technical issues, and the other mentor questions about instructional strategies and curriculum connections.
posing and responding to task based questions	Teachers will help each other when they ask, do something incorrectly, or appear not to understand.
posing and responding to task based questions	When a mentor steps away from the meeting to get a resource, the teachers turn to each other asking questions about school issues unrelated to the discussion.
posing and responding to task based questions	Mentors tell the teachers they are available to answer questions, in person or by email.
posing and responding to task based questions	When teachers show each other steps on the computer, they often let the learner use the mouse to go through the procedures while they are explained by the other teacher or mentor. However, if

	the procedures do not work, or they are short on time, then the other person will control the mouse.
Priority	Teachers will shift and even sometimes abandon their task, such as discussing technology planning, to address immediate concerns related to curriculum or school requirements.
Priority	Teachers will consult and work together to complete a task or discuss an issue that needs to be accomplished or resolved in a short period of time.
Priority	If teachers are short on shared time and need to accomplish something, they will discuss how to do something instead of actually modeling the task or working through it together.
Priority	Teachers will work on other tasks during meetings if they need to complete them before the end of the day.
Priority	Teachers will wait until the last minute to complete a required task (lesson plan, reflective journals), even when given extensions.
Priority	Teachers ask for additional instructional support from mentors at a time closer to their actual use their lesson.
Priority	Teachers will set additional meeting times to complete a collaborative task so that they do not lose momentum in their curriculum.
Priority	Successful developers have established their learning and development as a priority to commit time each week and not to interfere with their other responsibilities.
Professionalism	People in the school value teachers that treat teaching as a profession and not just a job.
Proximity	Teachers develop relationships and ask questions to people that are nearby their classrooms. Often, they do not interact with people that are in the next hallway, except during shared meeting times.
Proximity	Teachers sometimes wait to ask questions or ask for help until they see someone in the hallway or in a meeting.
Proximity	Teachers will help their peers learn procedures in a workshop setting if their peer next to them has fallen behind.
Proximity	Teachers will not ask a curriculum related question to a team member that does not teach the same class.
Proximity	Teachers sitting next to each other in a meeting will inform each other if they have missed any information.
Proximity	Teachers informally share ideas and get advice during shared time periods (bus duty, lunch, after school)
Reflection	Some teachers would prefer to figure out their own questions, but often don't have time, so they seek help from their peers.
Reflection	The development of the teachers can be halted if the mentors are not reflecting on their progress, with the exception of assertive or motivated personalities.

Reflection	Teachers and mentors do not have much time for reflection (Patty in the car, trouble responding to emails), and need to intentionally make time for it if they would like it to be part of their repertoire.
Reflection	The mentors did not ask the teachers to reflect on their learning experiences from their lessons during the shared time period. They feel that they could improve teachers' development by asking teachers questions to help them reflect on their own progress.
Respect	Teachers value the opinions of teachers/mentors that are experienced, have a class of students that have achieved, or have achieved professionally.
Respect	Teachers have a willingness and motivation to participate in activities that are led by someone they respect.
Respect	Teachers lose respect for people who belittle their work or do not understand how much work they need to accomplish.
Respect	Teachers that respect their students are often respected by their peers.
Respect	Mentors are noninvasive in approaching teachers or giving feedback because they respect the teachers' professional judgement to seek help when they need it.
Respect	Teachers feel motivated to contribute knowing that their work is respected by the community.
Responsibility	The teachers do not necessarily adopt the lessons that are shared during the planning meetings.
Responsibility	Stronger developers have taken more of a commitment of their learning to create activities. They feel that teachers should be prepared to contribute to the group discussion with ideas or questions in order for the group and its individuals to benefit.
Responsibility	The mentors introduce ideas and software/resources to the teachers. Following an introduction, the mentors are available for support and answering questions, but do not necessarily push the teachers in taking more responsibility to design lessons.
Responsibility	Teachers are given responsibility to complete a lesson and seek help when they are given independent time away from the mentors.
Responsibility	The mentors promote some responsibility to the teachers by asking them questions at meetings or providing reminders and summaries of near term tasks that need to be completed.
Responsibility	Teachers stop their participation in an activity if they feel they cannot hold responsibility to complete the requirements of the task.
Responsibility	Teachers will assume leadership of a task if they are the most experienced or knowledgeable person available.
Self-efficacy	Teachers like to feel comfortable and confident about their use of a software before using it with their class.

Self-efficacy	Teachers without much confidence in using technology enjoy support from the technology coordinator in the lab when they are using a software for the first time with their class.
Self-efficacy	Teachers without much confidence in using technology prefer to obtain handouts to give to their students that will guide them through the lesson.
Self-efficacy	Some teachers feel their peers produce higher quality work than they do, but does not deter them from trying or interacting with those individuals.
Self-efficacy	Mentors encourage successful developers to share their work with teachers who are not as confident in their abilities to use technology.
Self-efficacy	Successful developers feel they are capable of creating lessons from the start of their development by assertively asking questions when they need assistance. They don't doubt their abilities, even with lack of knowledge or experience.
Self-efficacy	Intermediate teachers feel comfortable designing lessons, and helping other design lessons, but still have some discomfort when implement in the lab because they are concerned that a problem may arise that they cannot resolve.
Self-efficacy	Some teachers with intermediate confidence and comfort work more independently because they don't want to bother using their peers' time for assistance.
Self-efficacy	Mentors do not pursue assisting peers that appear confident in their use of technology, even if they are unfamiliar with their work.
Self-efficacy	Teachers develop a greater interest in using technology as they see their student grow more comfortable and efficient using it in the lab (practice makes perfect).
Self-efficacy	Teachers feel more confident in their ability to mentor as they have more experience with successes and failures in the lab.
Shared tasks	The technology coordinator will work with teachers in the lab if they are having trouble or sign up for assistance.
Shared tasks	Teachers work together to complete a mutual task or obtain a common understanding of a task, such as producing something for the school or using CQI procedures.
Shared tasks	Teachers will plan lessons and activities together if they teach the same subject. Otherwise, they work independently.
Shared tasks	Teachers develop activities independently unless encouraged to work together. Instead, they plan what they would like to accomplish, and then divide responsibilities, where some of teachers will have to accomplish the same task (such as finding resources on the Internet).
Shared tasks	Teachers will seek to interact with someone that has a similar task if they lack understanding of the final product.

Shared tasks	Teachers feel they can accomplish shared tasks more effectively in small groups with a structured agenda.
Shared tasks	Teachers can complement each other with their skills when they collaborate in creating an activity, although most teachers chose to develop independently when given the choice.
Shared tasks	The technology coordinator reminds teachers by email that they can brainstorm with her for advice in creating a lesson.
Shared tasks	Teachers need a shared time to plan and discuss their work when they have a shared task.
Shared tasks	Inexperienced technology users prefer to partner up with more experienced peers as they develop their initial technology-rich lesson plans.
Shared time	Not having a shared time prevents teachers from sharing ideas and feeling connected to the group. In order to be aware of group issues, those teachers need to make a conscious effort to communicate with group members before or after school, or between passing periods.
Shared time	Teachers use shared time to share ideas and brainstorm, regardless if the time is structured.
Shared time	Teachers do not value intentional shared time if they do not have opportunities to discuss curriculum issues, or ask questions, relevant to their needs.
Shared time	Some teachers do not value shared time if it is not structured to accomplish a particular goal.
Shared time	Some teachers feel they have gained a lot of good ideas from structured shared time, whereas others feel those ideas would be shared through informal means.
Shared time	The structured shared time reduces the number of questions asked outside of that time since teachers feel it is a space where they can ask those types of questions.
Shared time	Some sharing occurs outside of structured shared time, but in many cases, communication is limited outside of shared time (mentors lose awareness, peers do not collaborate) unless additional time is planned.
Shared time	Teachers would prefer to meet once every two weeks for structured shared time, enough to keep the momentum and not feel that it is taking too much time.
Shared time	Some teachers (those who were not advanced developers) find it difficult to concentrate and be creative in structured shared time because they are concerned about their other school tasks.
Shared time	Mentors would prefer to have more one-on-one shared time as teachers become more independent in their development so they have greater awareness of their work.
Shared time	Some of the shared time was not used to address technology issues, especially if issues of priority came into play.

Shared time	Shared time in groups is not effective for novices if they do not understand the terminology.
Sharing ideas	Teachers share ideas to overcome classroom challenges and to improve student learning.
Sharing ideas	Teachers are motivated to share more ideas when they get positive feedback from their peers.
Sharing ideas	Teachers share ideas related to their areas of curriculum concentration and expertise. Mentors will share ideas from other curricular ideas, but won't speak too much about them in detail.
Sharing ideas	The technology coordinator shares ideas and resources with the grade level that individual teachers find.
Sharing ideas	Teachers often share ideas with their peers that teach in classrooms nearby.
Sharing ideas	Teachers obtain ideas from peers who are more knowledgeable, experienced, or creative.
Sharing ideas	Successful developers constantly search for new ideas, evaluate them, and flexibly incorporate the ones they like in their teaching.
Sharing ideas	Teachers share ideas in a group if they feel it has been successful in their classroom, and if no one has brought it up already in the discussion. In addition, they will discuss instructional strategies and how students might respond in the lesson.
Sharing ideas	Teachers share original ideas and resources, such as Internet sites, lessons from books and the Internet, and other software they have used in their classroom.
Sharing ideas	Some teachers gain ideas by looking at the hall displays of students' work from other teachers' classes.
Sharing ideas	Mentors will continue sharing ideas with teachers until they are prompted to start thinking of the teachers' development in creating (going beyond sharing).
Sharing ideas	Mentors will share ideas of teachers across groups.
Social obligation	More experienced teachers feel obligated to contribute their knowledge and ideas to the group because others have helped them when they were new at the school.
Social obligation	Leaders feel obligated to initiate group ideas if their peer leaders do not teach the same course.
Social obligation	Teachers feel obligated to contributed to a group activity if there is a shared goal and product represented by the grade level.
Social obligation	If mentors have left out information in a group meeting, more experienced teachers will add additional information based on their experience.
Social obligation	Teachers will complete shared tasks for other teachers if they are going to do it themselves (e.g., photocopy, calendar, etc.)
Story telling	Teachers use stories to help their peers relate to an experience (positive or negative), resolve a conflict, or provide an example.
Story telling	Many of the stories teachers share relate to challenges with

	student learning or behavior in the classroom.
Teaching	Successful developers learn about their lessons by examining their students' learning.
Teaching	Teachers are hesitant to use technology in their classroom if they are not prepared to answer student questions (they would like to anticipate student challenges), even if they feel comfortable designing the lesson.
Teaching	Teachers who are more learner-center than teacher-centered seem to adopt better to using technology resources, such as the Internet.
Teaching	Teachers find teaching ideas from those who are doing activities outside of the textbook.
Teaching	Teachers use of technology is influenced by their teaching beliefs (structured or resource-based/open-ended) - the types of programs they choose to use and activities students perform (project based vs. skill based)
Teaching	Teachers like working together with peers that have similar teaching styles.
Teaching	The technology coordinator will help model lessons for teachers when they start using a particular software in their classroom.
Teaching	Mentors often offer unsolicited instructional strategies to overcome potential learning challenges. However, they also emphasize providing resources to teachers and allowing them to make instructional decisions because the mentors/leaders are aware that teachers have different teaching styles (there isn't one 'right way' to use the tool, and it's ok to use it differently than what is suggested).
Teaching	Teachers feel they learn about improving their technology use through mistakes they make in the classroom. Most teachers do not feel deterred to continue using it after making a mistake.
Teaching	Teachers may be more assertive in their development because they are not aware of the amount of work that will later be expected of them, and that they are just trying to be the best teacher than can be. More experienced teachers, on the other hand, are slower to jump into their development so that they do not put too many things on their plate and feel overwhelmed with their work.
Teaching	New teachers have done well in adopting technology as a natural part of their lesson planning (more quicker than the past), whereas more experienced teachers see technology as an add on or even another subject.
Time	Teachers find it difficult to focus on producing quality lessons due to the time it takes to complete administrative paperwork.
Time	Successful developers focus on students learning, less than the lack of time they have to create quality lessons.
Time	Teachers prefer to be helped one-on-one when they feel they don't

	have time to look through a resource or explore on their own.
Time	Curriculum restraints, like CQI, prevent teachers from being creative in their lessons and incorporate additional resources, such as technology.
Time	Successful developers 'make the time' in their schedule to learn to use technology tools. Otherwise, they feel it would always get put on the 'back burner' and not addressed unless it was prioritized.
Time	Teachers need time to explore and learn technology tools independently. If they can't stay after school, then they need access to resources at home.
Time	Teachers are open to make time for their peers when they are helping them learn something, obtaining an idea for their classroom, or producing something that is dependent on their input.
Time	The mentors can not always help their peers due to scheduling conflicts, but are always open to email communication.
Time	Teachers and mentors will prioritize their administrative tasks and lesson planning before making time to reflect on their development or prepare for learning with their peers.
Time	Mentors will reduce shared time if they feel their peers are overwhelmed with other responsibilities.
Time	Teachers will not use a lesson in their classroom if they feel they do not have time to imbed it into their lesson planning.
Time	During meetings, teachers will multitask with other duties while discussing ideas. If something is particularly not relevant to them, the teachers will work on independent tasks while others are talking.
Time	Teachers feel they save time on planning by gaining ideas and lessons from their peers.
Time	Teachers will use their independent time to complete tasks of immediate priority, so technology lesson plans are not generated until they day they are due.
Time	Teachers feel they will alleviate time to develop once they become more adjusted to the school's culture and responsibilities, and have less administrative paperwork.
Time	During shared meeting times, teachers want to optimize their time by working through a structured agenda.