# Content-Focused Technology Inquiry Groups: Preparing Urban Teachers to Integrate Technology to Transform Student Learning

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**Abstract**

*This paper examines the process of establishing and sustaining content-focused technology inquiry groups, a teacher professional development model where groups of teachers with similar content and grade areas identify problems of practice and inquire into technology-supported solutions. Through a longitudinal case study of an urban arts-humanities technology inquiry group, this research reveals three phases of group development: (a) defining the group, (b) identifying content-focused technology inquiries, and (c) initiating content-focused technology inquiries. The main advantage of the first year of participation for teachers was their use of technology to solve content-related problems in their classrooms. Challenges included a shifting content focus for the inquiry group, time availability for participants' inquiries, and the availability of technological innovations that matched the participants' problems of practice. (Keywords: teacher learning, professional development, learning communities, technology.)*

At the national level, equipping our nation's schools with desktop computers, peripherals, software, and the Internet (technology) has been a major concern (Riley, Holleman, & Roberts, 2000; Riley, Kunin, Smith, & Roberts, 1996), and as a result, in the last decade, K–12 school technology planning efforts have focused predominantly on equipment acquisition and Internet connectivity (Porter, 2003). Consequently, technology infrastructure expenditures for K–12 schools have increased technology access across all schools. In fact, the ratio of students per instructional computer with Internet access in the United States has improved from 12.1 to 1 in 1998 to 4.8 to 1 in 2002 (Kleiner & Lewis, 2003).

However, access to these technologies in schools has not altered traditional instructional strategies and learning (Cuban, 1993; 2001) despite the promise of technology supporting innovative practice and transforming learning across subject areas (e.g., Chen & Armstrong, 2002; Duhaney, 2000). Uninspired technology use is especially prevalent in urban schools. Indeed, a digital divide of student technology *use* persists, for students in urban schools are more likely to use the computer for drill and practice or reward time activities than for problem-based activities that engage learners at higher cognitive levels (McAdoo, 2001; Scott, Cole, & Engel, 1992).

The challenge of integrating technology in ways that transform subject area learning for children, though particularly salient for urban school contexts, is

not a unique urban issue and is a collective challenge for teacher education. One major factor contributing to teachers' ill preparedness to innovatively use technologies to support student learning is the lack of ongoing, focused professional learning opportunities. Although 70.7% of public school teachers report participating in an average of 5.9 hours per year of professional development activities related to use of computers for instruction (Gruber, Wiley, Broughman, Strizek, & Burian-Fitzgerald, 2002; *Survey of technology in the schools*, 1999), these activities do not focus on integrating technology in support of subject area learning (*Survey on professional development and training in U.S. public schools,* 2000) and are predominantly organized as short-term, one-shot workshops focused on learning software without specific content-based examples of their use (McKenzie, 2001) and without pedagogical and curricular connections (Zhao, Pugh, & Sheldon, 2002). It is a natural consequence, then, that only one-third of public school teachers feel "well prepared" or "very well prepared" to integrate the use of computers into their teaching (National Center for Education Statistics, 2000). Better preparation of teachers to use technology to support student learning must be sought.

In response to this demonstrated need for better professional learning for technology integration, and consonant with recent reform efforts in teacher learning, we propose a professional learning model called content-focused technology inquiry groups that is guided by a situative perspective on teacher learning (Anderson, Reder, & Simon, 1997; Putnam & Borko, 2000) and builds on a growing number of inquiry group initiatives. This paper describes this approach to teacher professional development and illustrates the process of creating and sustaining a content-focused technology inquiry group in a local urban community.

## BACKGROUND: TEACHER LEARNING AND COLLABORATIVE INQUIRY

### Teacher Learning

Putnam and Borko (2000), using a situative perspective on knowledge, thinking, and learning, have suggested that teacher learning is affected by the physical or social context within which learning is situated, the kinds of discourse communities supported, and the accessible tools/persons. Designers of teacher learning activities need to be cognizant of the social context in which the learning is situated to maximize optimal learning. According to Putnam and Borko, the optimal learning environment situates teacher learning in and outside their school and fosters collaboration, discussion, and reflection opportunities. Research indicates valuable learning activities involve teachers reflecting on their own beliefs (Borko & Putnam, 1995; 1996), having access to alternative practices and beliefs that are reflective of their subject and grade level, observing the positive impact these practices have on students' learning (Richardson & Placier, 2001; Sandholtz, Ringstaff, & Dwyer, 1997; Snoeyink & Ertmer, 2001/2002), and engaging in learning over time (Darling-Hammond & McLaughlin, 1996; McKenzie, 2001). Collaborative inquiry, an emerging learning approach, espouses these research-based characteristics of optimal teacher learning in its underlying theory and practice.

**Collaborative Inquiry Group Approaches to Professional Learning**

Collaborative inquiry groups, involving small groups of teachers who collectively investigate pedagogical and content issues, have emerged as a promising strategy for facilitating sustained teacher learning (Crockett, 2002; Kasl & Yorks, 2002). For example, collaborative inquiry groups have been used to sustain educational reform in mathematics (Zech, Gause-Vega, Bray, Secules, & Goldman, 2000), to provide structure for professional learning and improving practice (Bray, 2002), and to improve teachers' early literacy instruction and student learning in K–2 (Ladson-Billings & Gomez, 2001). Within these inquiry initiatives, teachers developed content knowledge, engaged in critical colleagueship, and learned to actively create and sustain communities of inquiry.

In recent years, collaborative inquiry groups have been adopted for technology professional development (Bonk, Ehman, Hixon, & Yamagata-Lynch, 2002; Hovermill, 2003; Hunter, 2001; Keller, Ehman, & Bonk, 2003; Maloy, Verock-O'Laughlin, Hart, & Oh, 2003; Swan et al., 2002). These technology-focused inquiry professional development initiatives shifted away from the short-term technology "workshop" approach and, alternatively, incorporated many of the research-based characteristics of optimal learning. For example, Hovermill's (2003) participants shared a common subject area—mathematics—learned "technology-supported inquiry learning" as a pedagogical practice in mathematics education, and applied this pedagogy in the classroom using Fathom statistics software. In other initiatives, inquiry groups involved cross-content peers that shared a common purpose (e.g., Bonk et al., 2002; Hunter, 2001). Overall, the common content area or purpose facilitated sustained reflection and discussion regarding content knowledge and pedagogical beliefs. In the "workshop" approach to technology professional development, a lack of common subject area among participants has been cited as an impediment to learning (Snoeyink & Ertmer, 2001/2002).

All of these initiatives supported learning over time that, in turn, supported identification of worthwhile inquiry topics. For example, Hunter (2001) used a "problems of practice" approach that targeted new learning through inquiry of specific, situated issues relating to students, parents, curriculum, and/or pedagogy and subsequently "introduced technology applications as they were needed and available to support the pedagogical changes" (p. 482). Bonk et al. (2002) and Keller et al. (2003) offered university-led activities that introduced contemporary theory and new technologies before teachers identified "problems of practice" for action research topics.

However, potential transformation in instruction and learning as a result of the inquiries may be influenced by the way teachers identify their inquiries—either emerging solely from problems of practice, as in Hunter's approach, or emerging after being exposed to new theories or technologies, as in Bonk et al.'s (2002) and Keller et al.'s (2003) approaches. The new theories or technologies shared by university-facilitators (e.g., Bonk et al., 2002; Hovermill, 2003; Keller et al., 2003; Swan et al., 2002) may encourage teacher exploration of new learning methods or unfamiliar technologies. This strategy expands the discourse, tools, and, in some cases, the environment in which teacher learning occurs, be-

yond the familiar school setting (Borko & Putnam, 1995; 1996). Putnam and Borko (2000) note how "the [K–12] classroom is a powerful environment for shaping and constraining how practicing teachers think and act" (p. 6). Consequently, they raise the possibility that professional learning situated at school sites may be less successful in broadening teachers' thinking in new directions due to "patterns of thought and action [that] have become automatic" (p. 6). Thus, facilitators may be crucial to contributing contemporary research related to learning, teaching, and technology that may identify incongruity in teachers' patterns of thought and action.

These technology-focused inquiry group initiatives have established that collaborative inquiry learning is an emerging teacher learning approach for technology professional development that embraces many characteristics of optimal learning in a way that previous technology professional development approaches, such as the short-term workshop, failed to do. Consequently, we adapted the inquiry learning model, focusing on content-based technology integration in urban schools. Overall, for collaborative inquiry to effect change in teachers' practice, we felt several characteristics were vital, including: (a) participants having a common subject area background, (b) grounding teacher inquiries within teacher-identified problems of practice, (c) locating group activities at the school site, (d) including university facilitators, and (e) working as a group and dyads, when requested.

## CURRENT STUDY

### Research Methods

In March 2002, we established a content-focused technology inquiry group in collaboration with teachers in a local urban school. The research method implemented to study the content-focused technology inquiry group is a longitudinal, multiple-case embedded research design (Yin, 1994). The inquiry group is the case and the primary unit of analysis; embedded subunits of analysis are the practicing teacher and technology-supported practice in the classroom. This article reports on the process of establishing and supporting content-focused technology inquiry groups. The research in this paper reflects data generated between March 2002 and June 2003.

### Participants

Halverson Community School[1] is an urban K–8 school that is challenged by technology integration. Of Halverson School's 610 students, 83% are eligible for free/reduced lunch and 47% receive English Language Learner service. The school recently updated the computer laboratory, added new network wiring, established a computer-assisted instruction curriculum in math and reading, and intends to place three computers in each classroom by the end of 2004. With access to the Internet and computers in their classrooms or in an available computer laboratory, Halverson teachers find themselves with availability but not necessarily the knowledge or direction to use these resources for technology-supported problem-based learning in content areas.

[1] Pseudonyms are used for school participants' names.

In 2001–2002, Halverson School's district adopted inquiry learning groups for professional learning. The teachers' abilities to focus on topics of their choice allowed a Halverson teacher group to form around the issue of technology integration. Three middle school humanities teachers, Cory, Holly, and Frank, one music teacher, Maureen, and the middle school curriculum coordinator, Nora, decided to develop an arts-humanities technology inquiry group, covering three main content areas—English language arts, social studies, and music. Prior to their involvement in this group, the teachers reported very little participation in technology professional development. Nora learned the basics of word processing, databases, and spreadsheets in a Macintosh workshop. Holly and Nora learned a photo-editing software program in a one-day workshop, but without follow-up support, they never used the program. Maureen and Cory learned and used technologies through trial and exploration. In addition to the Halverson staff, four university participants joined the inquiry group. Joan, an educational technology professor, had teaching experience in the elementary and middle school levels. Ann, a doctoral student in Educational Evaluation, had facilitated technology integration among faculty at a Belgian international school. Shantia was a Masters student in Curriculum and Instruction, focusing on Learning Technologies. Terry, an undergraduate in English Literature, was awarded an undergraduate research award, and she chose to participate in this project. The inquiry group activities occurred at Halverson School, were guided by the teachers' content subjects, humanities and music, and were supported with on-site and university resources. Each teacher received a modest stipend of $150/year to compensate for data collection activities.

**Data Sources**

The data generated in this study included an initial (pre-involvement) interview with each participant that focused on the participant's experience as an educator, as a teacher of the discipline chosen for inquiry, and as a user of technology. Interviews were repeated with all participants on an annual basis. Classroom observations were conducted monthly for all teachers and were captured in written field notes. Inquiry group meetings occurred monthly and were audiotaped and transcribed. Meeting agendas were archived. Individual meetings and consultations with participants were logged in field notes. The inquiry group meeting transcripts were member checked by participants for transcription errors. All data were compiled in Nvivo software to facilitate both qualitative and quantitative analyses. Finally, we provided participants with a draft manuscript for their response to our interpretations of the data.

**Analysis Strategy**

The inquiry group case study relied on theoretical propositions (Yin, 1994) as the general analytic strategy. Based on past research and literature reviews, this project followed the proposition that content-focused, collaborative inquiry groups would facilitate teacher learning of technology and teacher use of technology for subject-specific student learning activities. This proposition led us to focus on the data mentioned above. This paper's focus on understanding *the*

*process of establishing and sustaining an inquiry group* necessitated the analysis of chronological events, a form of time-series analysis (Yin, 1994). Yet, the research literature has not yet established an explanatory theory that predicts the process of establishing technology-focused inquiry groups. Without a theory with which to compare our chronology, our analysis strategy expanded to include Yin's explanation-building analysis. Thus, we considered a wide set of variables, involving the teacher, the instruction, the inquiry group discourse, and the between-meeting activities, chronologically in order to build an explanation underlying the establishment and sustenance of the inquiry group.

The primary data sources for these analyses were the inquiry group meeting transcripts, meeting agendas, the pre- and post- teacher interviews, and classroom observations. These data had been coded using twenty-four top-level codes generated from previous research (e.g., Hughes, 2003; in press) as well as the wider literature on inquiry groups and teacher learning. Two researchers coded the data set and consensus was reached on all coding. Frequency tables of all coding across the chronological meetings and the teacher interviews revealed preliminary patterns. Further examination of the raw data excerpts allowed confirmation or negation of these patterns and, if warranted, elaboration of the emerging pattern. For example, the code "Questions about Technology" was frequent in data generated between March and May 2002. This preliminary pattern was further elaborated by examining the excerpts within the data corpus with this code during this timeframe. In this examination, we asked such questions as: Who is asking these questions? What kinds of questions are being asked about technology? Analysis of words spoken and turns taken by participants (Tannen, 1989) was conducted on the inquiry group meeting transcripts to identify participation trends. Three phases of activity, attendance, and discourse across the first fourteen meetings emerged from our data analyses.

**Results: The Implementation Process**

***Phase 1: Defining the Technology Inquiry Group's Identity and Purpose.*** The humanities inquiry group began in March 2002. Thus, our first five meetings occurred toward the end of a school year. Because the university professor envisioned the group's work being directed by teacher-identified topics, the first five meetings were spent getting to know each other, understanding the school structures, discussing the arts, humanities, and technology integration, seeing or hearing about technology ideas related to music, English language arts, or social studies, and identifying an overall purpose for this inquiry group.

Because the group was trying to establish direction, most teachers attended all the meetings during this phase. Group identity was one of the first topics discussed, as Maureen, the music teacher, wondered if she should be a member of the group. The university professor explained her hypothesis that content-specific groups might be more productive in learning technology, and the whole group decided that the "content" for the group was arts-infused humanities curriculum. Therefore, Maureen's participation was legitimate and necessary.

Discussion topics during Phase 1 included (a) school-based challenges regarding the use of technology, (b) humanities and arts curriculum, and (c) technology ideas

and options. Throughout the first five meetings, teachers repeatedly raised challenges in their school setting. For example, at the very first meeting, Maureen cited lack of time as "the biggest issue" related to using technology in her classes, and teachers indicated a lack of technology resources as well as problems with the school schedule that limited integrated curriculum opportunities. Despite Maureen's time issue, during this phase she identified hardware and software she had (e.g., piano keyboards) and wanted (e.g., digital recorders) to use. At the last meeting in Phase 1 (May, 2002), Nora, the middle school coordinator, suggested that an inventory of technology be created, indicating that the teachers did not necessarily know the hardware and software available in the media library.

Another main topic was the discussion of humanities and arts content. The university participants predominantly asked questions about humanities and music, and the teachers answered these questions and initiated discussion of curriculum. For example, Joan asked about the vertical and horizontal humanities and music curriculum. Frank discussed their use of looping, noting that they needed to decide who was going to teach what grade the following year. Holly raised the challenge of creating new curriculum, hoping that curriculum development could be collaboratively developed and used by all teachers rather than re-developed by each individual teacher each time he/she taught a new grade level. In 2002, the school had completed their seventh and eighth grades expansion by adding the eighth grade, so these teachers were still writing and refining their middle school curriculum. In fact, Nora, the curriculum coordinator, explained that participation in this group "is forcing us to articulate what we want to do with humanities. And I think if we were doing this [without the university participation], we just wouldn't take the time to sit down and start really pushing ourselves until this summer." Until the end of the school year, the teachers negotiated the curriculum topics for the following year, though Nora acknowledged writing their syllabi and curriculum maps would be completed during the summer.

Because this group had chosen an interdisciplinary focus, the participants explored the ideas of technology and curriculum integration. At the first meeting, teachers questioned levels of integration, specifically if "superficial integration" of arts-humanities-technology was warranted. Nora and Holly felt that starting superficially was the first step. Maureen described an example and stated, "…that is extremely superficial. Nevertheless, that's a place where I can start, that then we say, well what was that all about? And we get deeper and deeper and deeper." At the subsequent meeting, the university participants provided theoretical orientations to "integration" using arts-based examples. In addition, the university participants began to demonstrate hardware and software possibilities based on curricular topics mentioned by teachers. For example, teachers acknowledged that geography was a weakness in their humanities curriculum, and Geographic Information Systems (GIS) software was subsequently demonstrated and discussed in terms of its integration capability. Holly reflected on other geography software she had seen and voiced her worry and hope,

> …it just seems like [geography software] are kind of focusing on geography a little bit in a vacuum…I'd like to figure out a way to kind of

> embed it into what we're doing so it's not like okay now we're doing geography…if I'm doing Civil Rights, I'd like to see a unit on geography that talks about immigration in the early 1900s and where people went and to what cities…. not just like a map with all these lines.

Thus, the concepts of curriculum and technology integration were explored by examining examples of technologies and interdisciplinary curriculum, brought to the group by both the teachers and the university participants.

In this emergent collaboration, we were particularly concerned with the teachers' and university participants' verbal contributions. University participants spoke more than any school participant. Yet, the analysis of the structure and content of discussion indicated that both teachers and university participants initiated topics and that longer excerpts of talk occurred when university participants described examples of technology, lesson plans, or theoretical ideas. For example, in the second April 2002 meeting and the second May 2002 meeting, in which 75% and 80% of the talk, respectively, emerged from university participants, the main activity was explanation and demonstration of the GIS software.

Overall, in Phase 1 the inquiry group meetings focused on establishing an identity for the group and collaboratively exploring and defining the concepts related to "technology-supported, arts-infused humanities teaching," the negotiated content focus for this inquiry group. Teachers also acknowledged several site-specific challenges regarding actual use of technology in their classrooms.

***Phase 2: Reviewing Inquiry Group Purpose and Identifying Technology Inquiries.*** The first two meetings of the new school year, September and October of 2002, form Phase 2 of inquiry group development. Because the activities within these two meetings closely maintained the patterns of Phase 1, the intervening summer necessitated a review of purpose and agenda for the group. Consequently, discussion continued to focus on process—such as changing meeting times to a monthly schedule interspersed with individual meetings and reviewing the overall focus for the group. The university participants' talk was low (41%) in the opening meeting, which allowed topics to emerge from the participating teachers.

Specifically, focal activities also were proposed by and for the group during this phase. Though attendance was low during these two meetings, Nora, the middle school coordinator, recalled and proposed three technology-related action items. The group wanted to set up a digital video editing station so students could create a video about the school, to get GIS installed in Cory's classroom, and to know the technology capabilities of the school. Maureen also contributed her idea concerning the use of MP3 or other recording equipment in her music class. Cory and Holly had already expressed their interest in the GIS technology. Between meetings, Holly requested to use AlphaSmart keyboards, on loan to the university professor, in her writing class. By October, several technology-related projects had been identified, with explicit recommendation, interest, and support from the teachers, except Frank.

Demonstrations of technology possibilities, in which the university participants share new technologies that connect with content topics, did not occur as

in Phase 1. Because the teachers already had several technology initiatives of interest, showing other technology possibilities was not suitable at this point. However, Frank, who was absent at both these meetings and had not at this point expressed any committed interest in any of the technologies chosen by the other teachers, might have benefited from seeing more technology possibilities.

This phase was punctuated by teachers' selections of a technology inquiry and university and school participants' subsequent technology preparatory actions. For example, Joan prepared installation directions and delivered software materials to Halverson School's network specialist and provided Nora, the curriculum coordinator, ordering information for a GIS resource book; Ann collected a set of articles about art-humanities integration and technology-supported arts curriculum for Maureen, the music teacher; Ann and Shantia collected information about digital recording for Maureen; Ann began to supply up-to-date information about Halverson's technology resources and lessons using Halverson's technologies for the teachers; and Joan and Holly organized the use of AlphaSmart technology for a writing workshop. Technical and administrative problems slowed the GIS initiative. An installation problem hampered initial GIS training and was not resolved until early December, when Joan troubleshot installation with the school's network specialist. In addition, the GIS resource book did not arrive. Overall, in Phase 2 teachers identified topics to pursue and technologies to learn. University and school participants helped prepare for the initiation of the technology inquiries.

***Phase 3: Initiation of Technology Inquiries.*** Phase 3 was distinguished by action—teachers learning and using technology and university participants supporting learning and use. The teachers attended group meetings more regularly, with the exception of Maureen, the music teacher, and Holly, who began maternity leave in February. The regular attendance coincided with focused technology inquiries. All five teachers learned or investigated a new technology. Three teachers, Holly, Frank, and Cory, used the new technology in their classroom with students; two teachers, Nora and Maureen, took preparatory steps toward use. Teachers reflected on the learning and use of such technologies with colleagues during inquiry group meetings. As technology was used in the classroom, implementation challenges emerged. First, technology problems emerged on site; second, technology-related student learning issues were raised as a concern; finally, technology-related instructional problems surfaced.

Holly initiated the first inquiry, learning and using the AlphaSmart technology. In October, the university participants met with Holly, introduced Holly's students to AlphaSmarts, and observed student use in writing workshop activities. Holly's reflections about use of these technologies during the November 2002 inquiry group meeting inspired Frank's interest. Specifically, Frank wondered about students' motivation to write. When Holly confirmed that "there have been absolutely silent days, which is amazing for [those students]," Frank voiced his idea, "I'm wondering if something like this might be a nice motivation for the eighth graders with the essays they need to write." Between January and June, Frank's class used the AlphaSmarts regularly for writing purposes.

Holly, Cory, Frank, and Nora expressed interest in GIS. The university participants offered two GIS workshops—a one-hour introduction in early No-

vember (attended by all teachers except Maureen) and a three-hour workshop in April (attended by Cory, Frank, and Nora). Cory chose to integrate GIS in his humanities curriculum, and he asked Joan to familiarize his students with GIS by teaching a latitude and longitude lesson. Because he was teaching other groups at the same time, Cory did not gain more familiarity with GIS. However, this may be a suitable preliminary step toward integration as long as the teacher eventually becomes knowledgeable with the technology and instruction shifts to the teacher.

Nora and Maureen's technology inquiries—digital video and digital audio recording, respectively, were not accomplished during this phase. Technological issues and lack of time contributed to Nora's situation. She wanted to wait until her preferred multimedia station was set up in her office, which did not occur until late in the school year. She met with Joan in June 2003 to learn how the components fit together and preliminary steps for scanning and digitizing video because she intended to use the technology in the summer.

Maureen's technology inquiry was not accomplished due to lack of time, lack of focus on her interests within the inquiry group, and lack of appropriate technologies at the school. The university participants provided resource information for Maureen on her topic in October 2002, but a combination of Maureen's lack of attendance at the inquiry group meetings, her competing focus on National Board Certification preparation, and the inquiry group members' focus on AlphaSmart and GIS technology slowed Maureen's progress. In addition, the appropriate technology to do digital sound recording was not available at the school.

As the teachers learned new technologies and began to integrate them in student learning experiences, the monthly inquiry group meetings offered a chance to collaboratively explore the implications and complications of using technology and integrating arts and humanities in lessons. They discussed students' lack of higher order thinking skills, difficulty following directions, discipline problems, lack of preparation for class, and lack of writing skills. These general challenges emerged from discussions relating to technology-supported teaching, such as GIS or AlphaSmarts, or potential arts-humanities collaborations, such as connecting world music with studies of other countries or time periods. These challenges were raised without a great deal of constructive discussion, and thus, are natural teacher-identified topics to explore in more depth in the future.

Holly and Frank also raised instructional problems centered on the use of AlphaSmarts. For example, they noted that the teacher must develop strategies to prevent students from deleting each other's work when sharing the AlphaSmarts. A group discussion of consequences for violators challenged the teachers' notion of technology as a required learning tool for writing (such as a pencil) versus a motivational "add on" that could be removed. The teachers also considered the optimal number of students working with AlphaSmarts, solutions to curbing inappropriate writing, and use of AlphaSmarts by substitute teachers. These issue-based discussions assisted practical implementation and helped the teachers develop their vision for technology use in the classroom as integral or supplementary.

Certainly, issues with technology availability and support continued in Phase 3. The GIS resource book had still not arrived. GIS software installation was hampered by the school's security/network software and was resolved when the university professor worked on-site with the network specialist. Nora noted it took the school nearly a half-year to get the video-editing station installed in her room. Finally, Maureen felt she needed more digital recording hardware to capture students' music accomplishments. Whereas technology problems mentioned in earlier phases were more general in nature (e.g., not enough hardware), in Phase 3, the problems were more specific to teachers' technology inquiries.

## DISCUSSION AND IMPLICATIONS

The research in this paper focused on developing an explanatory theory of the chronological development of content-based technology inquiry groups against which future research on this topic can compare, because research and analysis to date has not had such a focus. Such comparisons over time likely will yield a predicted set of events that form the "basis for causal inferences" (Yin, 1994). However, we believe this first explanatory theory still provides insight into the development process and holds implications for teacher educators, professional developers, or school staff who may establish content-focused technology inquiry groups in the near future.

Group identity, focus, and participation were extremely important parts of the process. Even though the inquiry group chose "technology-supported, arts-infused humanities" as a content focus, the actual implementation process lacked infusion of the arts and, instead, focused more on humanities topics such as writing and geography. This raises issues regarding the factors that are likely to promote interdisciplinary technology inquiry groups' success. All members of inquiry groups must participate equally and focus on the content under study, especially if the content is interdisciplinary in nature. As recent literature illustrates (Crockett, 2002; Richardson & Placier, 2001; Zech et al., 2000), the learning in inquiry groups is facilitated when the members share similar content focus or learning goals. Rogers' (1995) writings on diffusion and innovation support the observation that participants need to be homophilous, or similar, on many variables (content area and grade levels, for example) and heterophilous, or dissimilar, regarding the innovation (new technologies, in this case). In order to avoid inquiry groups that involve participants who are heterophilous regarding content areas, future inquiry groups may wish to summarize the Phase 1 discussions on group identity and focus as a vision or goal statement, a document that can be referenced if member activities seem to shift away from the group goals.

This study also revealed that facilitation support was valuable. In the current study, the identification of technology inquiries was supported through the curriculum coordinator's school-based facilitation and leadership. However, participation of a media specialist or technology coordinator, we feel, would be a crucial part of a school-based leadership team for consultation and providing technology-related information and resources. The facilitator, or change agent, introduces some degree of heterophily (Rogers, 1994) into the group based on

his/her greater knowledge of educational technology as compared with the participants. However, Putnam and Borko (2000) warned that school-based professional learning occurring in a physical context where "patterns of thought and action have become automatic" (p. 6) possibly reduces teachers' inclination to change. In order to increase the chance that patterns of thought or action are broken, facilitators outside the institution may be invited to participate. Similar to Swan et al. (2002), the university facilitators in this inquiry group began discussions and demonstrated curricular tools that aimed to create dissonance within teachers' minds while the physical school site remained the same. In order for diffusion to occur, future inquiry group initiatives that occur in schools need to involve a facilitator or change agent who is more knowledgeable about the technological innovations than the group participants, and may involve facilitators external to the school, even occasionally, to provide an influx of new ideas related to the innovations.

With modest 45-minute monthly meetings and requested individual meetings, each group member began to learn to integrate one content-related technology into their curriculum within one year—a laudable accomplishment given that the research literature indicates a lengthier technology learning and integration process (Sandholtz et al., 1997). We attribute this success to the teachers' inquiries into technology emerging from problems of practice in the humanities. The effect of the district requirement to participate in inquiry learning remains unknown, although the requirement legitimized professional learning activities during the school day. Rogers (1995) acknowledges the importance of time in the process of innovation diffusion. In particular, Rogers acknowledges that time is crucial in the "innovation-decision process by which an individual passes from first knowledge of an innovation through its adoption or rejection" (p. 20). More accomplishments might have been made if compensation was available for work done after school. Voluntary groups may be challenged by participants' varied activity and time expectations.

Finally, we believe that encouraging and supporting inquiry group members to engage in action research projects related to their inquiries is needed (e.g., Bonk et al., 2002; Keller et al., 2003). In this way, their inquiry can move from oral informality to formal data collection and written and/or video-based documentation. For example, we envision a graduate course sequence targeting content-focused action research on technology integration that allows participants' professional learning to be formally acknowledged. In fact, it is just this kind of evaluation that other teachers use to make decisions about learning and using new technologies, as Rogers (1995) explained, "most people depend mainly upon a subjective evaluation of an innovation that is conveyed to them from other individuals like themselves who have previously adopted the innovation" (p. 18). These action research projects could become an expanding resource for other content-focused technology inquiry groups during deliberations concerning unfamiliar innovations.

This study reveals promise for content-focused technology inquiry groups as a professional development approach for urban teachers as well as teachers at large. Through inquiry study, teachers are tackling the collective challenge of in-

tegrating technology in ways that transform subject area learning for children. The three phases of inquiry group development we described in this paper may serve as a guide to the kinds of activities and accomplishments that can emerge from inquiry groups established at your institutions.

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