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CONTENT-FOCUSED TECHNOLOGY INQUIRY GROUPS: CASES OF TEACHER LEARNING AND TECHNOLOGY INTEGRATION

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ABSTRACT

Guided by a situated learning framework, this research examines the nature of teachers' technology learning when participating in a *content-focused technology inquiry group,* the ways teachers integrate what they learn into content-specific student learning activities, and how situated features of the learning context influence teacher learning. Longitudinal case studies of participating middle-school teachers reveal individual learning and technology integration accomplishments that were also inextricably linked to the group. The distributed nature of technology learning and integration evidenced in the cases raised the issue of whether teachers need to learn to operate the technology in order to integrate technology for student learning and the issue of sustainability when there is high reliance on participants outside the school organization during learning. The peer-supported learning also raised the wider societal issue about the role of teachers and highlighted the modest existence of professional learning communities in educational institutions. We recommend establishing technology inquiry groups within K-12 school settings and in teacher education courses.

Benchmark research (Sandholtz, Ringstaff, & Dwyer, 1997; Sheingold & Hadley, 1990) established that teacher learning about and integration of educational technologies in PK-12 settings is a lengthy process requiring a commitment, in some cases, of five years or more. Recent evidence that some school districts are building long-term, ongoing professional development about technology (e.g., Bradshaw, 2002) reflects shifting approaches to staff development that

promote teacher inquiry in ways that recognize this longer teacher learning process. Thus, research is only now beginning to examine how this nascent shift toward longer-term technology professional development initiatives may be improving teachers' ability to learn and use educational technologies in the classroom.

The research reported in this article examines the nature of teachers' technology learning when participating in long-term professional development, specifically in a *content-focused technology inquiry group* and the degree to which teachers incorporated electronic software or hardware in classroom activities to support students' content-specific learning (technology integration). The core of our model is the practice of collaborative inquiry (Kasl & Yorks, 2002), a learning approach that involves small groups of teachers who collectively investigate pedagogical and content issues. In our adaptation of inquiry groups for technology professional development, we incorporate a cross-section of characteristics that research indicates facilitate change in practice (Darling-Hammond & McLaughlin, 1996; Putnam & Borko, 2000; Richardson & Placier, 2001; Sandholtz et al., 1997) and reflects the new consensus model of professional development (Hawley & Valli, 1999). Specifically, participants engage in individual and collaborative inquiry: reflecting on their own beliefs through discussion with peers, considering alternative practices and beliefs about their content area and grade level, observing and discussing the impact these practices have on students' learning, and enacting new practices over time. Furthermore, this inquiry group is situated in the PK-12 school context, and participants agree on a common content topic, as past research (Snoeyink & Ertmer, 2001/2002) suggested that a lack of common subject area among participants in technology professional development is an impediment to learning.

Noting these characteristics, our approach to content-focused technology inquiry groups is theoretically aligned with a situative perspective on knowledge, thinking, and learning (Brown, Collins, & Duguid, 1989; Lave & Wenger, 1991; Putnanm & Borko, 2000). Whereas the format of a short-term technology inservice advocates the transmission of a set body of knowledge to be assimilated by the participating individual, the technology inquiry group approach acknowledges that the "knowledge" to be learned is actually a constantly changing and negotiated shared practice, a notion particularly apt in the field of educational technology where the pace of innovation causes technologies and technology integration to be a moving target. In a technology inquiry group, participants negotiate the "knowledge of technology integration," and the situative perspective brings into focus the "persons, actions, and the world [that] are implicated in all thought, speech, knowing, and learning" (Lave & Wenger, p. 52). In short, physical and social contexts shape the development of discourse communities that have access to particular tools with which learning occurs and cognition develops (Putnam & Borko, 2000).

Findings from research about teacher inquiry groups within other disciplines such as mathematics and literacy (Bray, 2002; Crockett, 2002; Kasl & Yorks, 2002; Ladson-Billings & Gomez, 2001; Zech, Gause-Vega, Bray, Secules, & Goldman, 2000) reveal these groups enabled participants to sustain educational reform, structure professional learning and improve practice, and improve teachers' instruction and students' learning. Overall, the research indicates that in inquiry initiatives, teachers have developed content knowledge, engaged in critical colleagueship, and learned to actively create and sustain communities of inquiry. This previous research warrants investigation of how inquiry groups might impact teachers' learning of technology integration, especially how the particular situated features of the learning context influence teacher learning.

This article reports research on the *content-focused technology inquiry group* model by examining the following questions:

- What do teachers learn about technology from participating in an inquiry group?
- To what degree do teachers integrate technology for student learning?
- How do situative elements (i.e., the physical and social inquiry group context and available tools) influence individual's learning and integration efforts?

Overall, this research contributes to emerging knowledge and practices of long-term, school-based technology professional development initiatives.

METHODS

Participants[1]

In 2001, the first author presented her concept of inquiry groups to the faculty at Halverson School, an urban K-8 school with 610 students, 83% who are eligible for free/reduced lunch and 47% who receive English Language Learner support. Three middle school humanities teachers, Cory, Holly, and Frank, one music teacher, Maureen, and the middle school coordinator, Nora, expressed interest in developing an inquiry group. Cory, Holly, Frank, Maureen, and Nora had five, four, eight, eighteen, and twenty-two years of teaching experience, respectively. In the spring of 2002 the five teachers began building an inquiry group with a university faculty member, Joan, two graduate students, Ann and Shantia, and one undergraduate student, Terry. Prior to involvement in this group, the teachers reported little participation in technology professional development. Nora learned word processing, databases, and spreadsheets in a Macintosh workshop. Holly and Nora learned a photo-editing software program in a one-day

[1] All teacher participant names are pseudonyms.

workshop, but never used the program, and Maureen and Cory learned and used technologies through trial and exploration.

Halverson School had school-wide Internet access, two computer laboratories in the media center, and an average of two or three computers in each classroom. In 2002, the school's technology predominantly was used for media classes and individual remediation with computer-based math or reading learning systems. All teachers could reserve a computer laboratory, if available, or send small groups of students to the media center to engage in computer-based activities.

Inquiry Group Context

The inquiry group activities began in March 2002. Participants met monthly for one hour at Halverson School. Between meetings, the university participants worked with individuals or small groups, and the teachers collaborated with each other. Cory's classroom had seven computers. Frank, Holly, and Maureen's classrooms each had two computer stations. Nora had access to a laptop. Additional technology resources, such as software and hardware, were available from the school media center or the university participants. Nora was the school-based leader of this group, as her extensive teaching experience, her seniority at the school, and her curriculum position helped her maintain the inquiry group. She organized the meetings, shared information between group members, summarized and reminded group members of tasks needing completion, and provided encouragement and motivation. Nora kept the group on task, acknowledged goals as they emerged, and helped the group progress through those goals. Nora was very knowledgeable about the standards and state mandates, which assisted group members as they discussed curriculum development and technology integration. The "content focus," "inquiry," and "integration" were not defined by the university participants but intentionally left to the teacher participants to negotiate within the group process. In past work (Hughes & Ooms, 2004) we described this group's process of developing and maintaining a technology inquiry group—a process during which these terms were defined. Initially, the group discussed examining how to integrate the arts (specifically music), humanities (the combination of social studies and English language arts), and technology. Maureen's professional commitment to National Board Certification in Music resulted in infrequent attendance at the inquiry group meetings, reducing her needs and interests from being heard and acknowledged by the group and ultimately, led the teacher group to focus exclusively on humanities curriculum and technology as the content focus. The teachers in this group adopted individual inquiry goals that focused on learning and using a new technology that potentially could contribute to solving a curricular or learning issue in the classroom. Finally, their discussions about integration focused on finding technologies that intersected with and advanced children's study of specific topics within humanities.

RESEARCH DESIGN AND DATA

This project used a longitudinal, multiple-case embedded research design (Yin, 1994). The inquiry group is the case and the primary unit of analysis; embedded cases are the practicing teacher and technology-supported practices in the classroom. The research reported in this article focuses on the embedded cases in order to understand the teachers' technology learning and integration from March 2002 through June 2003.

The data generated in this study involved pre-and post- structured interviews with participants 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 at the end of each academic year. Monthly classroom observations were captured in written field notes. Monthly inquiry group meetings were audiotaped, transcribed, and checked for accuracy by participants. Individual meetings and consultations with participants were logged in field notes. Data was compiled in NVivo software to facilitate analyses. Participants examined and responded to draft manuscripts to confirm or disconfirm our interpretations of the data.

Data Analysis

As the analytic strategy, this project used the theoretical proposition (Yin, 1994) that content-focused, collaborative inquiry groups would facilitate teacher learning of technology and teacher use of technology for content-specific student learning activities. We used the explanation-building analytic strategy, a type of pattern-matching, and analysis of chronological events, a form of time-series analysis, to build an explanation regarding teacher learning and technology integration in each embedded case.

The primary data sources for these analyses were the inquiry group meeting transcripts, the pre- and post-teacher interviews, and classroom observations. These data were coded using twenty-four top-level codes generated from previous research (i.e., Hughes, 2005) as well as codes that emerged during analysis. Two researchers coded the data set and consensus was reached on all coding.

An iterative process of explanation-building (Yin, 1994) used frequency tables of all coding to identify patterns for each embedded case (i.e., each participant) and initial case development began regarding the teacher's chronological learning and technology integration. Next, the initial case was compared against the theoretical characteristics of the situative perspective on teacher learning (Putnam & Borko, 2000) (e.g., did we see the physical context shape learning?). Revision of the cases continued in this fashion until we had exhausted our data and the theoretical characteristics of the situative perspective.

RESULTS: CASES OF TEACHER LEARNING AND TECHNOLOGY INTEGRATION

The results begin with three cases of humanities teachers' learning and technology integration. Each teacher case begins with a chronology, tracking the individual teacher's inquiry process across the first 16 months of inquiry group participation. Next, the teachers' technology learning and integration accomplishments are reported, and we explain how physical contexts, social relationships, and tools played a role in the individual's accomplishments. Finally, we close by noting any distinct patterns or issues in the case that will be addressed in the discussion.

Holly: A Case of University-Supported Technology Integration

In the group, Holly and her colleagues discussed the need to increase writing among students, especially students with writing difficulties. They felt that differences in motivation to write could be contributing to the disparity in writing ability and achievement. Holly became very interested in the AlphaSmart word processor demonstrated by the university participants in an inquiry group meeting. She perceived the technology could increase student motivation while supporting students' learning of the writing process, was willing to learn and use it with her students, and found the technology was available as a classroom set on loan from the university. Holly requested the university participants teach her how to use the AlphaSmarts, connect the AlphaSmarts to her classroom computers to download students' work, introduce her students to the technology, and visit the classroom while students used the AlphaSmarts for writing workshop activities. This teacher explained that the university participants provided her with a valuable support system. Holly independently planned her first writing workshop lesson that put the AlphaSmarts into her students' hands. In the subsequent inquiry group meeting, she shared with her peers that she felt her students were more motivated to write, wrote more text, and enjoyed the writing activities more when using the AlphaSmarts. Frank immediately expressed interest in AlphaSmart's potential for his students. Holly then used her experience and insight to help Frank plan and execute his own technology inquiry about AlphaSmarts.

In her inquiry, Holly learned the process of adopting a technological innovation to treat an identified curricular need. She and her peers identified writing as a needs area for their students, she recognized a technological tool that held the possibility of altering her students' writing habits, and she planned technology-supported instruction for her class. However, Holly did not learn to operate the technology; instead, she relied on the university support to guide her and the students.

In terms of integration, Holly put the technology into her students' hands as a mindtool (Jonassen, 2000) in that the students worked with the AlphaSmarts to

plan, write, edit, revise, and publish their papers. Inherent in this writing process is the activation of students' higher order thinking as they evaluate, analyze, connect, expand and modify their own ideas (Bruning & Horn, 2000).

In our analysis, we noticed how often Holly's inquiry was punctuated with university support around technology. In addition, Holly accessed her school peers to discuss curricular issues and to report her results. Throughout, Holly worked independently to treat a curricular need (writing) with a possible technology to enhance her students' learning. The university participants' demonstration and sharing of the AlphaSmart technological tool matched Holly's interest and needs. Furthermore, locating the inquiry group on the school site afforded Holly an easy transition from inquiry group meetings where tools were introduced, to her classroom, where she integrated these tools into her everyday practice.

In closing, Holly's case raises two issues. First, do teachers need to learn to operate the technology in order to integrate technology for student learning? Second, what are the implications for sustainability when there is high reliance on participants outside the school organization (i.e., the university participants)?

Frank: A Case of Collaboratively Developed Technology Learning

At the beginning of the inquiry group, Frank stated that he had not integrated educational technologies into his teaching. Initially, he appeared reticent to engage in a technology inquiry, as his attendance at meetings was inconsistent, and he was the least verbal participant at meetings he attended. His seeming disinterest shifted dramatically after Holly shared her perceptions of her students' writing with the AlphaSmart technology. Frank had not expressed interest in the AlphaSmarts when the university participants demonstrated them earlier and when the group discussed writing needs, yet Holly's reflections on using AlphaSmarts during a meeting kindled his curricular and pedagogical interests in this technology. Frank wondered out loud at the meeting if his students could also benefit from writing with AlphaSmart technology, and his inquiry began.

In subsequent monthly meetings, Frank facilitated group discussion to help him plan his use of the AlphaSmarts. His peers offered key insights into the planning and integration of AlphaSmart into his classroom. For example, Holly described the need for rules for the initial writing activity to introduce AlphaSmarts to Frank's students. She suggested that Frank use writing prompts. Prior to Frank's first use of the AlphaSmarts in his classroom, he set aside the university participants' offer to introduce the tool to the students and, instead, chose to organize a student mentoring process in which two of Holly's students helped teach Frank's students how to use the AlphaSmarts. For several months Frank sought input about instructional planning regarding his AlphaSmart integration from his peers during the inquiry group meetings. Then, Frank reported his findings; he articulated instructional modifications and strategies that enhanced his students'

writing activities with AlphaSmarts. For example, in writing lessons Frank arranged access to AlphaSmarts toward the middle of the unit because he realized that some students wanted to initially develop their ideas and then use the AlphaSmarts for outlining and writing. In his class, he also recognized that instruction with AlphaSmarts was most effective with students in small groups instead of one large group. The inquiry group first functioned as a collaborative instructional planning group for Frank and then became a peer audience with whom Frank was eager to share his technology inquiry accomplishments.

As a result of Frank's inquiry into AlphaSmarts, he learned how to operate the technology and how to integrate it into his writing lessons. To integrate the AlphaSmarts, he engaged himself in an iterative integration planning process that involved his inquiry group colleagues and his own classroom observations. Across several months' time, Frank used his observations of students' use and students' feedback to help him target his technology use to best assist students' writing activities.

Our analysis revealed a high frequency of Frank seeking or facilitating input and assistance from his teaching peers. Holly introduced the technology possibility that was adopted by Frank for his inquiry, and all the teachers co-developed Frank's integration plan. While Frank independently taught the planned lessons, he shared and sought feedback about each step with his peers. With no reliance on university colleagues, Frank created and experienced a sustainable technology inquiry and integration process.

Frank's case demonstrates the need to use peer recommendation as the main indicator for a promising technological innovation. What technology integration expectations can we have for teachers like Frank if they are not given time to work and share ideas with their peers? Further, what are the implications of technology possibilities being proposed only by teachers?

Cory: A Case of Misalignment between Technology and Curriculum "Tools"

As the inquiry group discussed the humanities, another important topic raised was the lack of inclusion of geography in their curriculum. The university participants compiled and shared a series of technology-supported geography lesson plans that intersected with their social studies and language arts topics. The teachers were particularly intrigued with lessons involving Geographic Information System (GIS) and twice requested university participants demonstrate GIS software capabilities. Concurrently, Cory suggested installing GIS on the seven computers in his classroom to facilitate easy access and use by any of the humanities teachers and avoid scheduling conflicts in the media center. Problematic installation of GIS resources hampered potential use for several months. In addition, school staff never fulfilled an order for a GIS teacher resource book that contained a series of lesson plans and data files the teachers wanted to

examine. Though this lack of access to GIS and the resource book hindered immediate learning, the university participants shared other GIS lesson plans and resources that were available at an Internet site. The group then requested and the university participants provided a training session using a latitude and longitude lesson they examined on the website.

Cory then proposed that his students do the latitude and longitude lesson from the training session, and Holly challenged Cory about the degree to which his proposed GIS lesson was connected to their humanities topics. Despite her challenge, Cory enacted the lesson by asking the university participants to teach the GIS lesson to small groups of students while he taught the other students. At the completion of the latitude and longitude activity, Cory had not learned GIS and reported students enjoyed the GIS, but he desired other ways it could be used.

Cory explained that there was no direct curricular fit between his humanities topics and available GIS data and lessons. Cory even suggested to Frank that GIS could be "big" when Frank covered the Depression topic. Nonetheless, Cory was still interested and pressed Joan from the university to identify other ways GIS could be used with his students in his upcoming humanities topics, Egypt, Greece, or Rome. Joan proposed using a theme of expeditions to connect GIS lessons on the Bancroft or Lewis and Clark expeditions to Odysseus' travels while learning geographical concepts or investigating modern-day travel on Odysseus' route. Nora's excitement around the expedition idea led to another GIS teacher workshop about the Lewis and Clark expedition and a student lesson using GIS to study Odysseus' trip. Cory mapped Odysseus' route on GIS and planned for his students to also map Odysseus' travels. Students completed the map activity, but Cory reported that his students were not very enthusiastic about the lesson. He attributed the lesson's mediocre reception to not being able to give more time from his curriculum to show students how to use GIS.

Cory's learning and integration of GIS was shaped by his immediate interest, curiosity, and enthusiasm for GIS technology. Yet, Cory experienced the challenge of integrating a new technology tool (GIS) with other enduring school "tools," such as the curriculum, class time, and computers. Ultimately, he expressed deep interest in GIS, recognized a need and usefulness for GIS in his curriculum, learned the GIS software, planned and executed a GIS lesson for his students, but explained that more time was required to plan "really good" projects, for he acknowledged that GIS did not fit well with all his humanities curricular topics.

Our analysis indicates Cory's heavy reliance on university participants in his learning and integration. The university peers introduced the GIS technology, taught the teachers how to use GIS, researched and compiled lesson possibilities, and even directed Cory's student in a GIS activity. Cory also independently led his students in another GIS lesson—the Odysseus expedition activity. The analysis also revealed Cory's perception of an incompatibility between the GIS tool and his curriculum topics for that year.

In closing, Cory's case demonstrates the need for significant scaffolded technology learning to initiate a teacher's own independent integration processes. His case also illustrates the fallacy of expecting one technology to be the "one" solution. Though Cory recognized GIS's many attributes, he ultimately recognized that it did not fit with his current curricular topics.

DISCUSSION AND IMPLICATIONS

The situative perspective on learning and cognition emphasize the relational (Lave & Wenger, 1991) or interactional view (Hung, 2002) of persons, tools, and actions within the world that ". . . considers the system—context, persons, culture, language, intersubjectivity—as a whole coexisting and jointly defining the construction of meanings" (Hung, p. 396). These three cases bring into focus a system that generated negotiated shared practice—in this case, technology learning and integration—that must be examined at the individual teacher-learner level and as a social system (Borko, 2004).

Lave and Wenger (1991) describe learning as occurring within a participatory framework. The participants in the technology inquiry group built a social context and setting along with particular social norms and expectations. This group negotiated and then expected a focus on humanities and technology integration. Within and among these cases, we saw evidence of this community of learners tapping the shared expertise across the participants to develop ideas and concepts and to negotiate meaning (Hung, 2002). Both Holly and Cory sought significant assistance from the university participants' expertise to propose technology possibilities, identify lesson plans, and work with their students. Frank relied on his peers to inspire his inquiry topic as well as help him plan his integration.

This sharing of expertise raises issues concerning distributed knowledge, scaffolding, capacity building, and sustainability. In Holly's case, she never learned the technology skills, rather developed and used distributed knowledge from herself and the university participants. This distributed approach did not inhibit her from planning and integrating the technology to support students' writing, but it could reduce her capacity to learn or integrate technology in the future. From the perspective of the National Educational Technology Standards for Teachers (NETS-T), Holly did not meet the first standard of understanding technology operations, a prerequisite skill for "applying technology in educational settings" (2000). Yet, the NETS-T are standards for individual teachers and do not accommodate distributed learning or knowledge. We feel further research needs to examine the relationship between teachers' knowledge of technology operations and their ability to integrate technology for content-focused learning. Cory similarly leveraged university participants' expertise and knowledge in his inquiry, yet in his second use of GIS, our analysis revealed Cory was taking more responsibility in the integration effort—essentially eliminating some of his

reliance upon university scaffolds. If the overall aim is to enable each teacher to *independently* sustain and build capacity in one's technology integration efforts, then these cases might introduce doubt about these teachers' abilities to sustain themselves independently in the future. However, we argue that these cases reveal the desire and need for collaborative technology learning and integration with a community of learners and that the propensity to sustain their integration is inextricable from their ability to continue learning within their inquiry community. Yet, increased use of professional learning communities in support of teacher learning may be limited, as Hord (2004) describes, until a paradigm shift occurs in both the public's and educators' views about the role of the teacher.

Tools, language, and symbols also help learners mediate within the social negotiated context they have developed. Frank's case implicates the source of "technology possibilities" as significant in that he was inclined to consider technology suggested by a peer (i.e., Holly). Rogers (1995) describes this as a common disposition among practitioners to pursue a technological innovation based on the evaluation of a peer who has adopted the innovation. Similarly, Zhao, Pugh, Sheldon, and Byers (2002) highlight the role of social support from peers as an important condition for successful technology integration. If this disposition is as common as Rogers indicates or Zhao et al. describe, it is important to facilitate peer-peer teacher collaborations in order to increase the likelihood for innovation and change.

Cory's case illustrates the fallacy of the "one solution" technology. In other words, a particular technology's promising features may induce teachers to feel compelled to adopt it. As Cory considered his curriculum more explicitly toward the end of the year, he finally acknowledged the GIS technology was not the best fit. To encourage teachers to think broadly about technology possibilities, professional developers need to provide access to *many* technology tools that connect with curricular interests and problems of practice. A way to meet this challenge could have been to include a district or school technology integration facilitator or media specialist who has extensive knowledge of all technologies available at the school site. Finally, Cory's case reminds us that teachers need to keep their problems of practice in mind as a priority when choosing to pursue a new technology. The humanities curriculum, as a "tool" to mediate learning, was introduced and referenced by the teacher participants; this does not appear to be sufficient, for Holly's interjections that questioned how Cory's intended use of GIS fit with his humanities topics were ignored or dismissed by Cory. Including a content specialist in the group might have kept Cory from investing his time in a technology that ultimately could not support the curricular topics he was responsible teaching in humanities. In addition, we felt that the inquiries might have been stronger if grounded in data; a content expert could assist the teachers in gathering and analyzing student data to identify real gaps in student learning. Supovitz and Klein's (2003) research of schools that use student performance data to improve learning and Love's

(2004) NSF-funded "Using Data Project" exemplify data-based activities inquiry groups could adopt.

This study of teachers' technology learning and integration accomplishments as they participate in a professional development approach, *content-focused technology inquiry groups*, illustrates the potential educative value of the inquiry approach for teachers' development. We encourage establishing technology inquiry groups of this type within school-based professional development practices, but our next step will be to establish school-based inquiry groups as part of university inservice education offerings to enable greater access to content experts, data-driven decision-making preparation, collaboration opportunities with peers in other schools, and the opportunity to receive university credit, district advancement, or an advanced degree.

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