Inquiry into Mediated Action: The Implementation of an Innovation Cluster

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Introduction

This study also looks at how two innovations, an emerging technology and a unit design framework are used to implement a constructivist-based learning environment. Rogers (1995) initially established a framework that helps to understand the complex process by which individuals and organizations adopt new ideas and practices. Any innovation represents an alternative way of completing tasks and solving a variety of problems. This study systemically analyzes how the two innovations are implemented in conjunction with each other and in the context in which they are used. Silverman and Bailey (1961) demonstrated that an understanding of the development of innovations as a cluster may be required to achieve the anticipated relative advantage of each.

The questions in this study define the relationship among aspects of the implementation of a reform-based unit which includes an innovation cluster of an emerging technology (Rogers, 1995; Hall, Wallace, & Dossett, 1973; Wilson, Sherry, Dobrovolny, Batty, & Ryder, 2001) and a framework for the design and implementation of a constructivist-based learning environment (Jonassen, 2000; Savery & Duffy, 1996; Lave & Wenger, 1991; Schank, 1994; Salomon, 1993).

Objectives and Purposes

The purpose of this study was to understand how teachers participate in collaborative professional development in order to implement an innovation cluster that included emerging technologies and a framework for a constructivist-based learning environment. The researchers focused on three progressive research issues during invivo data structuring: (1) What factors in a teacher’s school environments influence the implementation of an innovation cluster? (2) How does a teacher’s participation in collaborative professional development influence the implementation of an innovation cluster? (3) How does a teacher’s belief about learning and technology influence the implementation of an innovation cluster?

Significance

As a result of our study, we were able to describe the influences in the work activity of the teachers that affected the implementation of an online educational program. The study participants were 4 eMINTs teachers (enhancing Missouri’s InterNet Teaching) implementing an online authentic problem-solving unit simultaneously using advanced online technologies in four elementary schools throughout Missouri. Using cultural historical Activity Theory (AT) as a framework for analysis (Engeström, 1999), we created data structures based on the AT model and the concept of mediation (Wertsch, 1991).

We also integrated theoretical constructs from related fields including professional development (Shulman, 1986, Korthagen, 1993), innovation (Rogers, 1995), cognition (Bereiter, 2001, Lave, 1999) and collaborative problem solving (Salomon, 1993, Jonassen, 2000, Pea, 2001) into operationalized groupings of interactions in the local and collaborative work activity of the teachers. Additionally, we focused on three progressive issues during data analysis:
collaborative professional development, local context, and the teachers’ philosophical and pedagogical beliefs about learning in order to develop understandings of the influence of these factors on the implementation of the unit. We identified teacher responses to contradictions, pressures within their work activity settings, arising during the implementation of the unit. We then identified the response of the teachers to these contradictions as turning points. We evaluated these responses as resulting in a resolution of the contradiction thereby widening of the teacher’s object, the implementation of the unit based on their pre-unit goals, or turning point resulting in unresolved contradictions resulting in narrowing or disintegrating of their object (Ilenov, 1977).

As a result of this systemic and contextual identification of turning points and the focus on three progressive issues in order to clarify the relationships of these responses to the development of the object, we were able to identify influences that affected the effectiveness of the implementation of this reform-based unit based on the teachers’ motive for initiating change in their classroom.

Theoretical Framework

The theoretical grounding for this study was the sociocultural theory of human interaction, and development (Vygotsky, L. S., 1978, Bruner, J., 1990) with an emphasis on understanding the processes of mediated activity (Wertsch, J. V., 1998). The researchers used Activity Theory, (Engeström, Y., Miettinen, R., & Punamaki, R., 1999, Il’enkov, E. V., 1977) in order to design a systems framework for understanding the implementation processes in context and over time. Activity Theory defines the elements of human interactions systemically and allowed the researchers to design analytical procedures that developed systemic and contextual relationships among the dataset (Barab, S. A., Hay, K. E., Yamagata-Lynch, L. C., 2001 Schoenfeld, A., 1999). Using a systems-based methodology, the researchers studied the interactions of the constituents of the system that produce behavior (Aronson, 2003) and developed explanations that link the components as a “consilience of inductions” (Wilson, 1998, pg. 98).

The compelling purpose of systems analysis is to recognize the organizing relationships between entities in the system from which emerge the unique properties of the systems (Banathy, 1991). This form of analysis provides valid responses to complex social systems by making the interactions in the system explicit so practical and theoretical implications can be developed. Activity Theory (AT) provided the researchers with a set of models, strategies, methods, and tools that aided in the analysis of the work activity of the teachers. The overarching premise for this analysis was that the nature of human development is socially embedded and fundamentally activity oriented resulting in outcome, in this study, the development of constructivist-based learning environments using emerging technologies in order to expand the advanced learning processes in their students. (Cole, M., & Engeström, Y., 1993).

This study connects two interrelated educational innovations, an advanced online learning technology and the instructional design processes used to implement these technologies infused within a problem-based learning environment, as mediational tools instigated into the work activity system of the teachers. As a result the questions in this study define the relationship among aspects of the implementation of an innovation cluster (Rogers, 1995; Hall, Wallace, & Dossett, 1973; Wilson, Sherry, Dobrovolny, Batty, & Ryder, 2001) and the collaborative design and implementation of a constructivist-based learning environment (Jonassen, 2000; Savery & Duffy, 1996; Lave & Wenger, 1991; Schank, 1994; Salomon, 1993) within the teachers’ work activity systems.
The object of an activity system is something given and something anticipated. In this study, the conceptual object for the educators involved implementing the problem-based unit by means of integrating the innovation cluster. The researchers identified the contradictions in the work activity, structured around the three progressive issues, then focused on defining the turning points resulting from these contradictions as behaviors changing the implementation in the classroom and finally evaluated the resulting behaviors as a type of reformulation of the teachers’ objects, the implementation of the unit. As a result, the researchers were able to develop understandings about the collaborative professional development processes of the teachers and their relationships to implementation of the innovation cluster.

Methods

The researchers studied four eMINTS teachers who work with students in 4th and 5th grades in four different cities throughout Missouri who were implementing a collaborative online problem-based unit during the final quarter of the 2001-2002 school year. The students represented inner city, small city, suburban and rural students. enhancing Missouri's Instructional Networked Teaching Strategies (eMINTS) is a program developed by Missouri's Department of Elementary and Secondary Education (DESE). It establishes classroom computer labs in order to illustrate the use of technology in classroom instruction and develop models of inquiry-based instruction. These four eMINTS teachers were invited to participate in a pilot project at MOREnet (Missouri Research and Education Network) called ePioneers Program that involved learning about a new tool, Shadow netWorkspace™ (SNS) and developing a problem-based unit that incorporates constructivist-based learning methods and takes advantage of the many affordances of SNS. Because of their involvement in the eMINTs program, the ePioneers teachers had the same prior amount of technology training and the same quantity of technology in place in their classrooms.

The data collection process used interpretive research practices (Fraenkel & Wallen, 1996) to capture the dynamics and complexity of learning processes throughout professional development (before, during, and after implementing the unit). The goal of data collection was to capture professional development in a way that enables the researchers to fully realize its complexity and make it available for analysis. The data collected from the teachers included initial and follow-up interviews, transcripts from a phone conference and seven chatroom conferences, messages posted on discussion boards, reflective questionnaires related to their design of the unit and the principles of constructivist learning, an online journal, and documents the teachers produce related to the unit and technology.

Using Activity Theory (AT) to define the constituent components, nodes, of the work activity of the teachers, the researchers used N*UDIST software to structure the nodes of the AT model (e.g., motive, goal, subject, mediation, object, community, rules, division of labor, outcome) and integrated the theoretical constructs from related fields (e.g., professional development, innovation, collaboration) into operational categories of interactions in the work activity of the teachers.

Results

Each teacher’s transformative processes were analyzed through the hierarchical identification of contradictions in AT. When external elements, such as new mediational tools, become part of a teacher’s work activity system, internal contradictions, or tensions, result between two nodes of the activity system. In order to develop their object, the effective implementation of the unit, the teachers needed to resolve the contradictions resulting from their efforts to implement new elements into their work activity.
Secondary contradictions were identified within each individual teacher’s activity setting. These contextual contradictions defined the progressive issue, what factors in individual teacher’s school environments influenced the implementation of an innovation cluster? Each teacher had between 3-4 contradictions in their school settings that constrained their efforts to implement the unit. One teacher widened her object as a result of overcoming secondary contradictions. Two teachers narrowed their objects as a result of their inability to resolve these types of contradictions in context. The researchers used the AT Model to show secondary contradictions. Contradictions unresolved are shown as solid broken lines in AT Model shown as Figure 1 below. Resolved contradictions are shown as dashed broken lines. The teacher that successfully resolved contextual contradictions was able to formulate and communicate her goals and intents for her reform efforts to her co-workers and facilitate the development of her problem-solving unit and the integration of the new technologies.

![Figure 1. AT Model of a Teacher’s Work Activity System](image)

A tertiary contradiction occurs between interacting activity systems. This type of contradiction occurred when the teachers collaborated to define a common object. The researchers coded the teachers’ online dialogs to define the dialogic turning points as text instances when the teachers redefined their object and changed an aspect of their implementation in their classrooms (Kärkkäinen, 1999). This type of contradiction defined the second progressive issue, how does the individual teacher’s participation in collaborative professional development influence the implementation of an innovation cluster? Three of the teachers reformulated their object because of these online collaborative processes. One teacher shortened her schedule as a result of collaboration dialogs despite her own concerns about the limits it placed on her goals thereby narrowing her object as a result. The two other teachers were able to widen their objects, adding activities and evaluations, as a result of the collaboration process.

The researchers designed a transformation model, figure 2 below, that identified tertiary contradictions that occurred over the course of the study. Using the transformation model, the researchers found that all the teachers narrowed their object during a difficult collaborative phase of the unit when all their students were online in synchronous chatrooms. The collaboration process available to the teachers, a weekly online chat, was insufficient to aid these teachers in resolving contradictions during this phase.
A primary contradiction defines the relationship between motive and outcome. A primary contradiction is as negative tension between the concepts underlying the implementation of the object, in this study the motive was defined as development of advanced learning abilities in the students, and the ultimate result that the agent hopes to achieve, outcome. This type of contradiction defined the progressive issue, how do individual teacher’s beliefs about learning and technology influence the implementation of an innovation cluster?

The researchers identified relationships between the pre and post levels in outcome in order to evaluate their relationship to the overall development of their object. The researchers coded these as hierarchical levels of the teacher’s philosophy of learning using Bereiter’s Scheme of Knowledge to identify changes in their learning goals for their students (Bereiter, 2001) as they stated them pre and post unit.

These overall transformative processes developed into contradictions in the development of two of the units. One teacher narrowed her object, stopping the chats among her students and the other students, because of her belief that the learning processes augmented by the online technologies, the development of multiple perspectives during problem-solving, were not beneficial to her students - a disparity from her stated pre-unit learning goals for her students. Another teacher widened her object from her pre-unit motive as a result of identifying and overcoming her primary belief contradiction that her students were unable to develop advanced learning processes. She credited the professional development program with her ability to implement the unit more fully than she originally anticipated.

Implications

In response to the first progressive issue, local context, teachers who are implementing innovation should develop communication support structures in their local community that allow them to resolve the eventual contradictions in their local activity setting. Anticipatory problem-solving and design processes are beneficial constructs for reform-based professional development models.
In response to the second issue, collaboration processes, the researchers found that teachers implementing innovation who are working in local contexts with little collaboration experiences can benefit by collaboration outside their local environment with teachers implementing similar innovative units. However, teachers who are already working at a high level of innovation in collaborative and supportive local contexts may not benefit, or can even reduce the effectiveness of their reform units as a result of collaboration. As a result, collaborative processes should be modified to fit the level of collaboration and innovation of the participating teachers.

In response to the third issue, beliefs about learning, teachers implementing units designed to develop advanced learning processes in their students can have primary contradictions between their beliefs about learning and the processes required for practical implementation of the mediational tools that they bring into their classroom in order to meet their original learning goals for their students. Identification of the gestalt theories, the phronesis and espisteme, (Korthagen, 1993) and reflection on these concepts (Schön, 1987) can benefit teachers implementing reform by aiding them in addressing the contradictions between their paradigm and their praxis.

Higher-Order Learning and Advanced Technologies

Change in education can be a sporadic process as teachers respond to pressures to use the new technological tools more readily available in schools and attempt to incorporate new concepts about learning emerging from research in cognitive science. However as teachers attempt to reconcile these new understandings about human learning processes and the addition of these new technologies into educational processes there are no assurances that the two will be compatibly linked and utilized for the development of knowledge needed by students participating in a post-industrialist, knowledge-based, modern society (Bereiter, 2002). Research suggests several reasons for the inconsistent impact of technology on education (Means, 1994; Means, Blando, Olson, Morocco, Remz, & Zorfass, 1993). When teachers attempt to implement a technology innovation, they naturally face the complex challenge of fitting together new ideas with deep-rooted beliefs and practices. The introduction of new cultural tools, such as technology and new concepts about learning and knowledge, mediates the action of the agent (Wertsch, 1998). Cultural tools contain both affordances and constraints and insert a source of tension into the system. As a result, teachers often introduce an innovation in ways that reflect a negotiation between old and new ways of doing things (Bruce, Peyton, & Batson, 1993; Bruce & Peyton, 1990). This ongoing, evolving process of negotiation occurring during the implementation of this unit and the innovation cluster and the results of those processes are the concepts this study will describe and analyze.

The National Center for Education Statistics (2000) reported that nearly all public school teachers surveyed had computers available somewhere in their schools, while 84% of teachers had at least one computer in their classroom. Although access to technology in public schools has increased, the impact of technology on reform efforts in teaching and learning has been mixed. In the Report to the President on the Use of Technology to Strengthen K-12 Education in the United States (President’s Committee on Technology, 1997), the committee of advisors recognized the benefits of constructivist philosophy in education and recommended looking more closely at the constructivist pedagogic model and the role of technology as a tool to mediate the development of knowledge responses. Contemporary constructivist-based learning principles suggest that students should actively participate in goal-based activities that provide them the opportunity to construct knowledge responses to meaningful issues. According to Jonassen, Peck, and Wilson (1999), constructivist learning involves knowledge that is constructed not transmitted, embedded in activity, and anchored in the context of the activity.

Our knowledge-based society necessitates students exiting the educational system with the ability to create understanding and represent that understanding as productive knowledge. A
society places greater demands on educational systems to develop learners who can use knowledge in new areas and different situations educators are attempting to reform how students learn and respond to their learning environment. Bereiter (2002) contends that knowledge implies that the purposeful use, recombination, evaluation, and redistribution of information are the core abilities of a knowledge-based society. Internet technology can give learners the tools that allow for expanded forms of communication, analysis, and expression (e.g., visualization tools, access to authentic issues and problems, ability for students to share work, access to authentic resources, and opportunities to collaborate), the Web-Based Education Commission (2000) contends that educators have not yet fully developed the potential of Internet-based technology. Learning to think critically, to analyze and synthesis information to solve problems in a variety of contexts and to work effectively in teams are crucial skills for modern employees. There is a need to understand how our educational systems can develop these skills in students (Bransford, Goldman, & Vye, 1991).

Additionally, there is a need to develop an understanding of the influences of professional development processes on teachers implementing reform based on these concepts. Previous studies have studied reform processes in professional development in education (Korthagen, 1993; Shulman, 1986; Schön, 1983; Lieberman, 1996). These studies have identified the importance of collaborative professional development for teachers implementing reform that involve both advancement of the teachers’ understanding of current cognitive theories (episteme) as well as the development of the practical (phronesis) instructional design aspects necessary to implement units based on these theories (Korthagen, 1993).

References