

Inquiry into Mediated Action: The Implementation of an Innovative Online Problem-Based Unit into K-12 Classrooms

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Abstract: The purpose of this study was to understand how teachers implement an innovation cluster that included an online workspace and a framework for a problem-based learning environment. The researcher focused on three progressive research issues during 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? Using Activity Theory for apriori structuring of the data set and these three progressive issues for invivo analysis, the researcher found that the teachers implemented the innovation cluster in relation to their ability to identify and overcome contradictions in their work activity.

Theoretical Background

The theoretical grounding for this study was sociocultural theory of human interaction and development (Vygotsky, 1978; Bruner, 1990) with an emphasis on understanding the processes of mediated activity (Wertsch, 1998). The researcher used Activity Theory, (Engeström, Miettinen, & Punamaki, 1999; Il'enkov, 1977) in order to design a systems-based framework for understanding the implementation processes in context and over time. Activity Theory defines the elements of human interactions systemically and allowed the researcher to design analytical procedures that developed systemic and contextual relationships among the dataset (Barab, Hay & Yamagata-Lynch, 2001; Schoenfeld, 1999). Using a systems-based methodology, the researcher 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 then 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 contextually relevant responses to complex social systems by making the interactions in the system explicit so both practical and theoretical conclusions can be developed. The overarching premise for this analysis was that the nature of human development is socially embedded and fundamentally activity oriented resulting in an outcome. (Cole & Engeström, 1993).

Using Activity Theory (AT) to define the constituent components, nodes, of the work activity of the teachers, the researcher then 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. 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. The researcher 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 of the unit and finally evaluated the resulting behaviors as a type of reformulation of the teachers' objects, the implementation of the unit with the potential outcome, motive, of developing advanced problem-solving abilities in their students.

Methods

This study connects two interrelated educational innovations, an advanced online learning technology and an instructional design template for a design problem-based unit, as mediational tools (Wertsch, 1988). The progressive questions in this study define the relationship among aspects of the implementation of this innovation cluster including defining the characteristics of innovative educational technologies (Rogers, 1995; Hall, Wallace, & Dossett, 1973; Wilson, Sherry, Dobrovlny, Batty, & Ryder, 2001) and the characteristics of the collaborative implementation of a constructivist-based learning environment (Jonassen, 2000; Savery & Duffy, 1996; Lave & Wenger, 1991; Schank, 1994; Salomon, 1993). The data collection process used interpretive research practices (Fraenkel & Wallen, 1996) to capture the dynamics and complexity of the educational settings. 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 the documents the teachers produce related to the unit and technology.

The researcher studied four eMINTS teachers who work with students in 4th and 5th grades in four different cities throughout Missouri who were voluntarily implementing a collaborative online problem-based unit during the final quarter of the 2001-2002 school year. 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 the Pioneers Program that involved learning about a new online tool, Shadow netWorkspace™ (SNS) and collaboratively developing and implementing 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 Pioneers teachers had the same prior amount of technology training, 3 years, and the same quantity of technology in place in their classrooms. Table 1 below identifies the classroom settings.

Table 1: Setting of the study

	Grade	Community	Students	Technology Access
Linda	4 th	suburban	12 boys and 10 girls, all Caucasian	As a part of their participation in the eMINTS program, each teacher has 12-14 Pentium3 LCD computers, a teacher workstation, laptop, a Smartboard and projector, a scanner, a color printer, and a digital camera.
Helen	4 th	rural	12 boys and 12 girls, all Caucasian	
Janice	5 th	urban	7 boys and 10 girls, all Black or African-American	
Carolyn	4 th	mid-size city	9 boys, 10 girls; 11 Caucasian, 8 Black or African-American	

Findings

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? The researcher designed an AT teacher model for each teacher to show secondary contradictions. An example of a teacher's post-unit AT model is shown as Figure 2 below. Contradictions unresolved are shown as solid broken lines in AT Model. Resolved contradictions are shown as dashed broken lines. The top of the triangle represents the new tools (SNS and problem-based unit) inserted into the work activity of each teacher. In this study there were two new tools the problem-based unit design template and SNS. The middle of the triangle shows the subject (teacher) on the left with an arrow connecting over the course of the unit the subject to the object. In this study the object was the implementation of the unit using SNS. The outcome of the object is the ultimate potential for the unit. The teachers described their potential outcome as the development advanced problem-solving abilities in their students with the awareness of multiple perspectives. The bottom of the triangle depicts the contextual issues, the aspects of her local environment that impact her ability to meet her goals. These categories include rules, the rules in her school or district, community, others in her local context that can aid or hurt her ability to reach her goal such as her principal and division of labor, those

people necessary for her to reach her goal such as technology support personnel. The factors I identified for each node were assigned after initial interviews with the teachers. A post-unit AT Model for Linda is shown below as Figure 2. All the teachers encountered multiple unresolved contradictions in their classrooms as they implemented their units. Linda had two unresolved tool-based contradictions, one related to subject, her beliefs about problem-based learning, and the other to object, the unit itself. She overall narrowed her object by ending the online dialogs with the other classes. She stated that the synchronous chats were “chaotic”. Helen had two context to object contradictions, one that was division of labor, she did not communicate with her technology support person, and the other community-based, she shortened her unit to stay with the online teachers and could not complete the unit as a result.. Overall she disintegrated her object by not completing the unit. Janice had a rule to object, departmentalization issue, and tool to object contradiction, issues with SNS. Despite these context-related issues she overall expanded her object as result of her collaborative efforts. Carol had two subject-related contradictions, one related to her concepts of a tool, the unit which she thought was too difficult for her students, and one related to a rule, her class within a class structure. She overall expanded her object by completing all the unit activities in conjunction with the other teachers despite her belief that the unit was too difficult and her students were not learning useful knowledge.

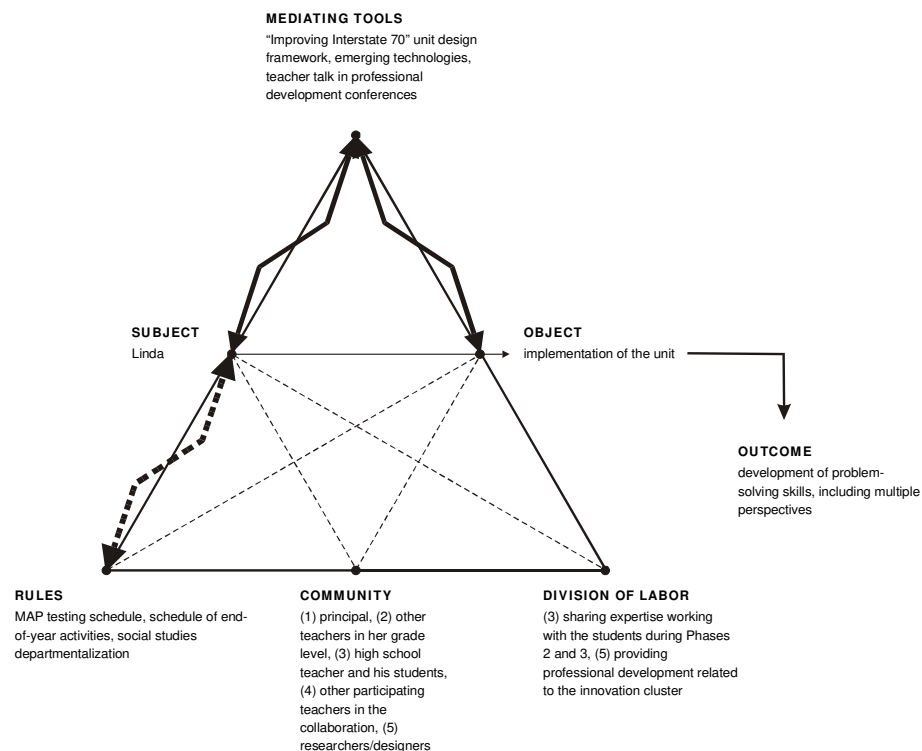


Figure 1. AT Model of Linda's Work Activity System

A tertiary contradiction occurs between interacting activity systems. This type of contradiction occurred when the teachers collaborated to define a common object. The researcher 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 of the unit 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. Janice shortened her schedule as a result of collaboration dialogs despite her own concerns about the schedule and she was unable to complete the unit as a result. Both Janice and Carol were able to widen their objects, adding activities and evaluations, as a result of the online collaboration process. Linda made no changes in her implementation as a result of the online chat dialogs.

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 researcher identified relationships between the pre and post levels in outcome in order to evaluate their relationship to the overall development of their object. The researcher coded these as hierarchical levels of the teacher's philosophy of learning using Bereiter's Scheme of Knowledge to identify changes in her learning goals for her students (Bereiter, 2001) as each teacher stated them pre and post unit. These overall transformative processes developed into contradictions in the development of two of the units. Linda 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. She stated in her post-unit interview that she did not want to develop problem-based learning processes in her students but instead prepare them for the standardized test. Janice, the urban 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 as a result of their interactions in the problem-based unit. She credited the online professional development program with her ability to fully implement the unit and develop advanced problem-solving abilities in her urban students. Carol did not resolve contradictions between her ideas of her students' capabilities and the problem-based unit. She felt the unit was too complex for her students and a "waste of time." Helen did not have any pre-unit contradictions about the learning unit and the online technology.

The researcher designed the Transformation Model, figure 2 below, to depict the identified contradictions across the cases as they occurred during the study. Each of the teacher's final AT model is shown in the center of the circle. The collaboration process is shown as a broadening and narrowing line outside the circle. It enlarges if the teacher resolves a contradiction and narrows if she does not. The progressive AT Models of the teachers are shown outside the circle as Pre-Unit, Phases 1, 2, and 3. Turning points, changes in teacher activities in their classrooms, are identified as a TP in the line going through the AT models for each teacher. Using this transformation model the researcher found that all the teachers were unable to resolve contradictions during a difficult collaborative phase of the unit when all their students were online in synchronous chatrooms. Additionally the two teacher who described themselves as collaborative in the pre-unit interview did not resolve any contradictions as a result of the online dialogs and either narrowed or disintegrated their object. The two teachers who described themselves as not collaborative in the pre-unit interview both expanded their object as a result of the online interactions. Linda and Helen were coded as givers of information in their online dialogs with Janice and Carol coded as asking questions which they subsequently used to develop new processes in their classrooms.

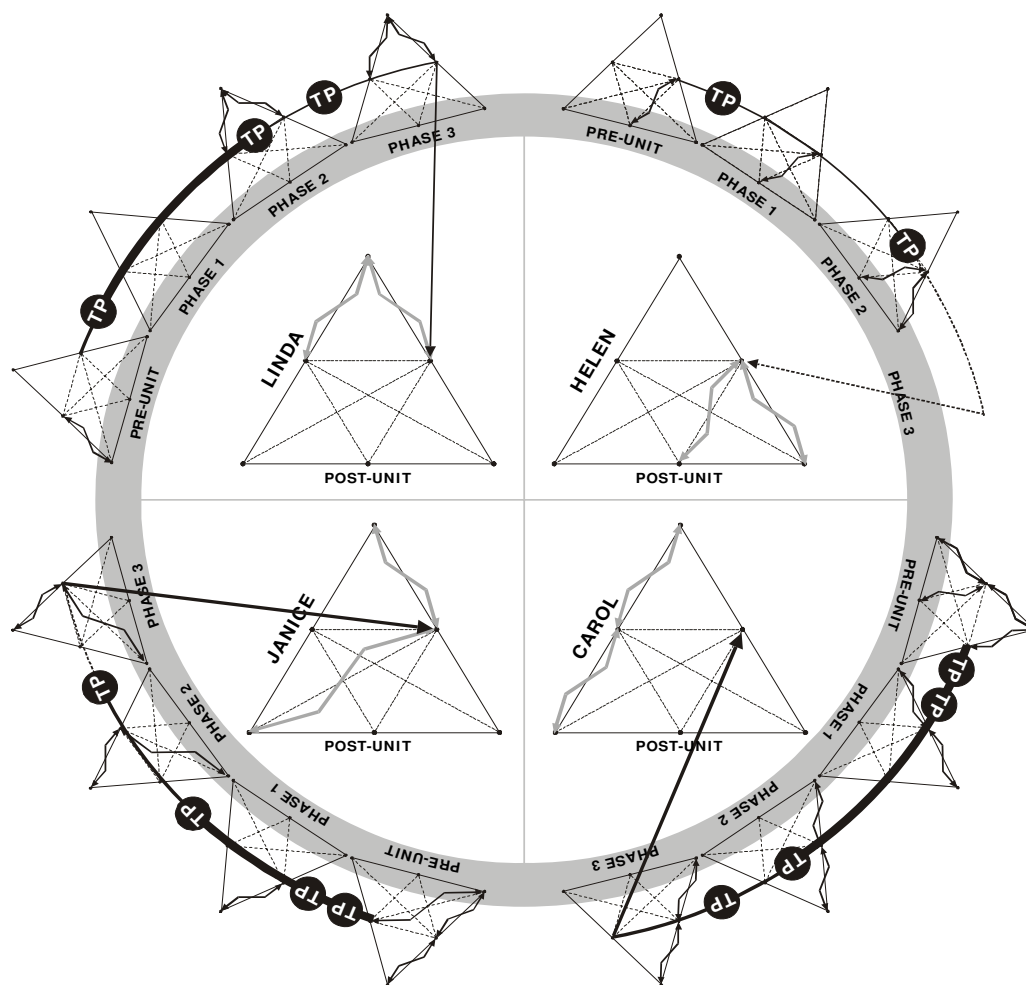


Figure 2. Transformation Model

Conclusions

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 for innovative educators. In response to the second issue, collaboration processes, the researcher found that teachers implementing innovation who are working in local contexts with little collaboration experiences can benefit by collaboration outside their local environment with other innovative teachers implementing similar 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 with other teachers below their level of innovation (Russell, 2004). Collaborative processes should be designed to fit the varied levels of previous and current 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 these learning goals for their students.

Teachers who are designing and implementing constructivist-based learning environments need a reflective proactive form of communication as part of their professional development in order to “clarify concepts, ideas, and alternative courses of action” (Korthagen, 1993, p. 318). Teachers who design and implement innovation into their classrooms must be ready to adapt their instruction to meet the demands of

a "complex and multifaceted endeavor" (Blumenfeld, Soloway, Marx, Krajcik, Guzdial, & Palincsar, 1991, p.390). Elbaz (1991) illustrated that teachers' knowledge is non-linear, holistic, imbued with personal meaning and largely tacit. Clark (1979) found that teachers' actions seem to be governed by rules and routines, with decision-making in a studied, deliberate sense taking a minor role in their interactive thinking. These studies demonstrate that creating a reflective professional development program for innovative educators can help teachers identify their tacit knowledge and understand the types of innovative pedagogical knowledge that can aid them in developing new pedagogical and philosophical concepts in order to implement innovative learning environments. A professional development model for innovative educators should help teachers be both problem-solvers and proactive collaborators and communicators. In order to develop innovation effectively, teachers need to be supported by varied processes and forums of interactions with other teachers or mentors working on similar innovations. Innovative teachers need the challenge and support gained through productive social interactions in order to clarify what they believe and gain the courage to pursue their beliefs (Zeichner & Liston, 1996) in order to be effective innovators.

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