

The Complex of School Change:
Personal and Systemic Co-development

William Barowy
Lesley University
Cambridge, Massachusetts

Cindy Jouper
Educational Service District 113
Olympia, Washington

Abstract

This article describes the mutual development of a school system in a poor rural county with one of its teachers. We recount the conditions leading to the coordination and writing of a Technology Literacy Challenge Fund proposal to ameliorate inadequate computer technology and initiate pedagogical change. We apply the expansive methodology of Cultural Historical Activity Theory to explicate personal and systemic developments. We examine the concept of activity identity by relating it to movement and action across activity systems, and by contrasting it to the notion of self-efficacy. We find a theoretical problem emerging with the delineation of people's activity into separate systems and scales of time.

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Introduction

When the first author, Bill, drove towards Raymond in Washington State, it was to teach a weekend format course for a Technology in Education master's degree program. Driving south toward town, 75 minutes from Olympia, through drizzling rain, he first saw clear-cut hillsides, with large uprooted tree-stumps and debris scattered over bare ground. The scene was cataclysmic. Upon arriving, he saw the lumber mill, and then the small houses and trailer-homes. Many homes were under-maintained. He rounded the bend near the grocery, and thought, "OK, soon we'll get into town" only to find himself crossing the town limits into the next. "Oops, missed it." Turning around, a heavy realization descends. "This is it. . . Oh my!" This town was not the usual place that he taught in. Although the program often draws teachers from all places, material requirements for computer labs and Internet access usually restrict teaching sites to wealthier settings. Puzzled by this observation he asked himself out loud "How did we get here?" Continuing to ask this question over the subsequent four years kept him in touch with Cindy, the co-author for this article.

This article describes the mutual development of a school system in a poor rural county with one of its teachers. The analysis centers on activity leading to and involving the coordination and writing of a Technology Literacy Challenge Fund proposal to ameliorate inadequate computer technology and to initiate pedagogical change. We contextualize the study in three ways. First, we provide a brief overview of relevant dilemmas with educational reform, advancing computer technology, and the limited resources and isolation of rural schools. Second, we explicate our own roles, engaging in

praxis to actively promote social and technological change in education. Third, we introduce relevant theory and some of its critical issues.

We then apply the expansive methodology of Cultural Historical Activity Theory (Engeström, 1987) to shed light on personal and systemic co-developments. The Raymond school system and Educational Service District 113 (ESD 113) are delineated and modeled as separate systems of activity, respectively becoming foreground and background. We examine the concept of *activity identity* by relating it to movement and action across activity systems, and by contrasting it to the notion of *self-efficacy*. We then find a theoretical problem emerging with the delineation of people's activity into separate systems and scales of time.

Method

The expansive methodology can be compared to a hybrid case study approach. Our study falls across the traditional historical case study and the psychological case study (Merriam, 1988), as the research problem itself falls across institutional and individual units of analysis. The study does not follow an inductive ethnographic process but, like traditional psychological case studies, proceeds through the coordination of observations with theory (Merriam, 1988). Two institutions, the Raymond school system and ESD 113, an educational service district agency that supports school reform, are modeled as activity systems (Engeström, 1987). In this article, we focus primarily on changes in the Raymond system, with ESD 113 in the background. We apply the expansive methodology developed by Engeström (1987). Briefly, this involves delineating the systems of activity, identifying dialectical contradictions that spur transitions from one developmental phase to another, locating concepts and models shared in these systems through historical analysis, and identifying those concepts and

models that are taken up in subsequent practice. In activity theory, contradictions—dilemmas, disturbances, tensions, and problems—are understood to be the precursors of development, as they put people in the position of having to change something in order to resolve the contradiction. Actions that do not change the extant social organization comprising the contradiction leave the problem in place.

We address the problematic issues of bringing theory to bear when attempting to span social and individual scales of analysis. At the individual scale we examine the ways, not dissimilar to that theorized by Penuel and Wertsch (1995), in which Cindy's participation in activity with cultural and historical resources makes her self, and how mediated action plays a role. Drawing upon the notion of development as a "complex dialectic process" (Vygotsky, 1978, p. 73) we examine the transformations from inter-psychological activity to intra-psychological activity and back. Comprising the data for the study are interviews, email exchanges, artifacts, photos, observation field notes, and, to richly characterize town and school system contexts and student performance, statistics from state and federal governments.

The first author, Bill, was primarily responsible for the data gathering and the theoretical interpretation of the case study. As co-author, Cindy offered personal insights into how her own development connected to that of the Raymond school system over several years. Cindy's authorship brings formal recognition to her work and the responsibility to ensure that the issues studied and analysis presented in this text reproduce her account of personal change with a greater fidelity than if she were treated solely as a subject. To a degree, the dialectic of theory and practice for this paper is enacted through the division of labor between the two authors. The dialectic reflects the core issue and tensions of ecological validity in psychology (Bronfenbrenner, 1979; Cole,

Hood & McDermott, 1997) and sociology (Cicourel, 1982). Ecological validity in psychology generally refers to whether an environment created for an experiment is experienced by the subject in the same way as assumed by the investigator (Bronfenbrenner, 1979). Similarly, sociological concerns with ecological validity reflect the artificiality of data gathering. If the subject's and the investigator's interpretations of their shared discourse are different from each other, the value of such data may be questioned (Cicourel, 1982). The core issue in both fields is that the processes of investigation can differ in significance for the investigator and the subject of the investigation. We encountered this difficulty when the first author began making interpretations mediated by a theoretical framework that the second author did not, at least initially, share. The problem is sharpened because the second author's experience is much more intimately involved with the events under investigation. Co-authorship attempts to bridge this divide by bringing together the two authors' perceptions and their interpretations of their experiences in the production of the text. Through this production we have encountered challenges in bringing our different perspectives to bear when creating a single document. De Vries offers a rich discussion of postmodern concerns with voice, authority, and subjectivity in cultural descriptions for which co-authorship may offer some relief (de Vries & MacNab-de Vries, 1991). The approach, however, is inspired by Friere's (1999) methodology of the co-investigation of generative themes:

To investigate the generative theme is to investigate people's thinking upon reality and people's action upon reality, which is their praxis. For precisely this reason, the methodology proposed requires that the investigators and the people (who would normally be considered the objects of that investigation) should act as *co-investigators*. (p. 87)

Technology and Reform; Isolation and Under-privilege

Societal conditions are part and parcel of the deep contradictions that schools face today. At this time in the United States, increasing efforts at school and teacher reform (Hallinan & Khmelkov, 2001; Little, 1993; Tyack & Cuban, 1995) are occurring simultaneously with increasing computer adoption (Cuban, 2001; Means, 1994). These forms of educational innovation are immersed in a technological and social milieu that is not static, but is changing rapidly (Adams, 1996). Computer technology is advancing at an increasing rate, with capacities in microprocessors, data storage, and network speeds growing exponentially (Stix, 2001). Rapid improvements in computer technologies accompany new approaches and methods across many specializations, and together they constitute a "diverse, overlapping, interacting set of sociotechnical systems" (Adams, 1996, p. 266) which is "subject to many heterogeneous, often conflicting influences" (p. 3).

Both authors of this article are employed in training educational professionals how to use technology. Considering the reproductive function of schools (Bowles & Gintis, 1976), it is not surprising that the social and technological facets of educational change reflect the dynamic complexity of the milieu. Today, educators face a bewildering array of federal, state, and professional organization demands for standards and achievement for both students and teachers. In less than two decades, federal and professional organizations have developed a multiplicity of national K–12 content standards in at least 17 content areas. One deep contradiction that states and schools face in implementing these goals is an inverse relationship between statewide testing policies, on the one hand, and both teaching standards and student performance, on the other (Darling-Hammond, 2000). Adding to this dilemma, critics of change point to the under-

use of computer resources (Cuban, 2001), the disconnection between school reform efforts and technology adoption (Means, 1994), and the isolation between schools of education and the elementary and secondary schools whose teaching positions they fill (Hallinan & Khmelkov, 2001).

On the surface, teachers' practices seem to be keeping pace with technological advances. While in 1995, less than 10% of teachers felt competent to use computer tools (Office of Technology Assessment [OTA], 1995), in the year 2000, 66% of public school teachers reported using computers or the Internet during class time for instructional purposes (National Center for Education Statistics [NCES], 2000). The rapidity of technological change, however, constantly threatens disparity in the availability and use of technological resources along economic and geographic lines. In 1998, high school students in the household income group earning under \$20,000 used computers at home for school work *5 times less often* than those in the \$75,000 and over income group (NCES, 2001). In 1998, people in rural areas were 50% less likely to have Internet access than those earning the same income in urban areas (National Telecommunications and Information Administration [NTIA], 1999). In 1999, the number of rural households with access increased 75%, although a new disparity appeared in the form of broadband Internet access (NTIA, 2000). As technology advances, poor rural schools and communities find themselves continually struggling behind schools in urban and suburban areas. Yet research in rural education, which would expose and document the problems that rural schools face, is also struggling with limited resources (Sherwood, 2000). The situation begs the following questions: Considering the tensions that technological and reform demands create with geographic and financial constraints, how

do schools succeed? How are educators managing and adapting to these conditions?

What are the success stories that can serve as models for others?

Individual Development and Institutional Change

In our work of training educational professionals, we both are engaged in stimulating and enacting educational change, "pushing" technological innovation. It is a complicated and difficult ensemble of goals to reach. *Praxis*, as "reflection and action upon the world in order to transform it" (Freire, 1999, p. 33) emerges as a useful day-to-day strategy. Against the exigencies of the job, however, a conceptual framework that is rich enough to guide intervention has not been easy to come by. One encounters the no man's land between psychology and sociology (Cole, 1996; Wertsch & Penuel, 1996). It is a deep and long lasting problem—arguably underlain by contradictions in the human sciences between theories and the object of understanding the human condition. On the one hand, stand-alone psychological and cognitive science paradigms that place analytic primacy in the individual—"located in heads" (Lave, 1993, p.12)—do not contextualize learning and development. On the other hand, sociology focuses primarily on social relations (Durkheim, 1982) and glosses individual development. Yet, in the works of Marx and Durkheim, both of whom theorized social change (Giddens, 1984), there is a general appreciation of the reciprocal developments between individuals and their societies. "Durkheim says . . . that 'we are at the same time actors and acted upon, and each of us contributes to forming this irresistible current which sweeps him along'" (Giddens, 1971, p. 71).

Consequently, the first author's interest has turned towards approaches in the ecology of human interaction and development (Bronfenbrenner, 1979) that take human activity as a unit that is "analyzable in its dynamics and transformations, in its evolution

and historical change" (Engeström, 1987, p.39) and that account for culturally and technologically mediated action (Wertsch, 1998). Activity systems theory (Engeström, 1996a; Leont'ev, 1981) offers dialectical analysis of the development of people and instrumentation, accounting for the social and material distribution of cognition in the course of collective object-oriented activity. Culture and its history of development indispensably enter into the analysis of social interactions in the present (Cole, 1995, 1996). By comparison, the concepts of object-orientation, technological mediation, historical development, and cultural milieu are not as fully articulated in an alternative framework commonly referred to as *community of practice* (Lave & Wenger, 1991; Wenger, 1998).

Separately, the two of us have been in situations in which we have been employed for one institution in coordination with another to achieve educational change, funded by grants. There is a significant need to describe the processes through which one institution is implicated in the transformations of another. In parallel, activity theorists have encountered situations in which new modes of interaction arise from the intersection of otherwise independent social systems. *Third generation activity theory* (Engeström, 1996b) is emerging in response to these challenges. We have chosen not to bring the Communities of Practice (CoP) framework into our analysis. Identifying boundaries is an essential analytic move for determining what crosses the boundaries of social systems, and by comparison to activity theory, CoP theoretical categories are not as tractable for specifying those boundaries. Furthermore, CoP favors "negotiation of meaning and formation of identities" (Wenger, 1998, p. 189) over economic and artifactual mediation categories. The major contradictions between societal demands of reform and technology, and the constraints of economy and isolation are better addressed with activity theory

(Engeström, 1996a). Several of the activity theoretical categories—*production*, *consumption*, *exchange*, and *division of labor*—are not only theoretically constitutive for educational institutions functioning in a capitalist society (Bowles & Gintis, 1976), but, in our view, are essential for cognizing school change in systems with limited resources.

Through our preliminary analysis of how ESD 113 was implicated in Raymond school change leading up to and during the “Olympic Class Learners” grant, the prospect arose that Cindy's personal development served an essential function in the interaction process between the ESD 113 and the Raymond schools. More theoretically, the coupling between the two social systems occurred as her person embodied changes through interaction in one system, and, as a changed person, participated in expansive activity (Engeström, 1987) in the second system. Thus, the central interest of this article is to investigate how, and with what forms, prior individual development is implicated in innovative systemic activity.

Writ large, the development of an individual involves the formation of identity. Penuel and Wertsch (1995) assert that identity research best be located in the study of mediated action. Similarly, it has been suggested that the concept of identity be extended to depict “both a part of the inner self and the outer context” (Westerberg, 2001, p. 17). We address the concept of identity to the extent that, in the act of goal-oriented creative action, “the social determination of an individual reveals itself with full force” (Zlobin, 1990, p. 60), on the one hand, and that the individual is “more than just a product of social relations” (Nikiforov, 1990, p. 102), on the other hand. We have found the notion of *self-efficacy* (Bandura, 1977, 1997) useful for filling the conceptual void in how individual development takes place in creative settings, and how the past then unfolds as

"active, conscious and creative influence on the objective world" (Zlobin, 1990, p. 60) in later settings. We contrast self-efficacy to the sociocultural notion of *activity identity*.

Making the Future with the Past

In 1992 Cindy faced a dilemma. She had started teaching in Raymond in 1979 and had gradually progressed in her use of computer technology, as it became available. She found ESD 113 to be a source of computer software in 1983, and she started taking classes there in 1991. At ESD 113 she learned about the new Macintosh computer and technology enhanced science teaching. Cindy's goal of empowering children's learning actions by putting computers into their hands resonated and grew with the support of Dick Barnhart, who is currently the Director of the Educational Technology Support & Services Center at ESD 113. The problem was that there were not enough computers in the school to reach this objective. She had managed to obtain a couple of machines, and borrowed the desk machines of other teachers from time to time, but moving and returning the loaners took time and effort. In a small school, in a poor community, there were bound to be problems of "have" and "have-not" if she managed to acquire more solely for her own classroom. Technical and social equality formed a barrier to Cindy's goals. This difficulty was compounded because her colleagues did not match her level of desire to put computers into the hands of children. Through her own development, Cindy personally came to feel the tension between the pedagogical goal of empowering children with technology, and the economic and social constraints of her school system.

What to do? In 1992 her colleagues wanted to know more about computers but they did not want to make the 75-minute drive to ESD 113 to take classes. Consequently, Cindy began offering her own classes in Raymond. To circumvent barriers with the district office, she offered classes for free at first. In the next year, there was still a strong

demand for classes so she worked a deal with the district to split the cost with the teachers. Although her teaching teachers built social capital in Raymond, it still did not solve the equipment deficit. With no clear solution, she began adjunct teaching for ESD 113, simply because the ESD made a public invitation. In the 1996-97 school year, Cindy and two colleagues from Raymond participated in a state-funded grant called Partnerlink, which linked three large suburban school districts and four small rural school districts. She received a computer and several cameras as part of that effort. She helped plan and provide staff development for a grant called ELWAT (Essential Learnings–Writing and Technology) that ESD 113 wrote, and she assisted with the running of the grant, including developing the grant's web page.

At this time, Raymond received the request for proposals (RFP) for the Technology Literacy Challenge Fund (TLCF) from Office of Superintendent of Public Instruction (OSPI). The OSPI is the primary agency charged with overseeing K-12 education in Washington State. The Technology Literacy Challenge Fund provided formula grants to states to accelerate the implementation of state wide educational technology. OSPI administered the RFP. The program's key purpose was to enable states to assist school systems that have the highest numbers or percentages of children in poverty and that demonstrate the greatest need for technology. When Cindy read the RFP, she thought, "We can do this!" Not everyone agreed. There was resistance. A colleague recollects:

Cindy had first read about that grant and then came to us and we all panicked and said, "We can't do that, we don't know enough about technology to do that." And she said "But if we never try, the rest of you will never know about technology.

Bandura's notion of self-efficacy, one's perceived ability to produce a given level of attainment (Bandura, 1977, 1997), developed through personal performance accomplishments or through witnessing the accomplishments of others, reflects one aspect of Cindy's uptake from her participation in the work of ESD 113. Her personal view of what she could do grew out of her work at ESD 113 by participating in one grant and helping to write another. She writes, "All of these factors together gave me the confidence to apply for the grant." Self-efficacy contrasts with the sociocultural notion of identity in activity (Penuel & Wertsch, 1995; Westerberg, 2001), as *identity across activity*. Cindy benefited from her prior participation with grants at ESD 113 while her colleagues did not. That any instance of self-efficacy is highly personal and idiosyncratic may be a consequence of what Bandura terms "triadic reciprocal causation" (Bandura, 1997, p.6), which recognizes dependence upon intra-psychological dimensions, actions, and environmental dimensions. While the latter two dimensions vary from one context to the next, the first is embodied and shaped by the past. In comparison, activity identity includes the history of a person's participation in activity, arguably within one activity system. What is important to keep in mind is how, on an ontogenetic time-scale, Cindy's embodiment of successful participation in prior grant work at ESD 113 enabled her to initiate the proposal process in Raymond (which had little history of grant making).

It can be argued that Cindy could have initiated the grant without ever having been at ESD 113. We find it unlikely, as it was more than just her image of her self that contributed to engaging others in the grant process. The inter-personal element of agreement among the school staff to participate with Cindy in the proposal process points to identity being more than an intra-personal construct, in agreement with Penuel & Wertsch (1995) and Westerberg (2001). Actions that are coordinated with others require

a social complement to self-efficacy. That is to say, an individual's interactions leading to systemic change necessitates the cooperation of others involved, and this cooperation may depend upon the others' views of a person's capabilities to achieve results.

Accordingly, what changes a person can make, systemically, depends upon how *others* believe in one's capability for performance and how subsequent actions, enabled by those beliefs, support those other persons' developments.

Two Systems of Activity

Many institutions write proposals professionally. The system that forms the background for this article, ESD 113, is one in which there are established proposal-writing practices, a supporting division of labor, and an experienced proposal writing staff. These are people who have developed expertise in working with funding agencies, in meeting RFP requirements, in networking between organizations, and in crafting persuasive documents. ESD 113 is located in Olympia Washington and is a 75-minute drive from Raymond. When visiting, one notices the signs that this institution is deeply invested in supporting improvements in education. In the Educational Technology department there are computers, servers, and video equipment. There is a media center that members of the district can access for materials or training. Together with the technology are people who may be teaching teachers how to use it. Other people may have their hands in a computer repairing it, and still others may be writing grants to help schools integrate computers into their classrooms. The discourse there is replete with technological terms, curriculum content, and philosophical approaches to education. There is a great deal of experience distributed throughout the building.

This is not the situation with Raymond, which forms the foreground system in our analysis. The Raymond school system serves a poor rural and small town. Up to 1997

there was no record of initiating grant proposals. Knowing only this, it would be curious to see the school system complete a large proposal. Reminiscent of Barker's work with the size of schools (Barker & Gump, 1964), however, the division of labor in this small town is not as specialized as in larger communities, mostly due to the smaller number of residents. It is a common practice for tasks to be shared among people, and complementarily, for any one person to be capable of doing many things.

The distribution of proposal writing tasks illustrates the close integration of the Raymond community that contributes to making it a special setting for *productive interdependence* (V. John-Steiner, personal communication, October 12, 2001). After initial staff meetings with Raymond and South Bend teachers and school boards, the grant writing committee developed sufficient agreement in the two communities to pursue the proposal. With approximately two months between the receipt of the RFP and the deadline for the proposal, time was short and *every person on staff* took a part of the grant to research information. A colleague, Sandy, became the organizer, planning the timeline for the drafting of the proposal, and coordinating people's work, ensuring that critical tasks were completed. Cindy incorporated the information provided by Sandy's coordination to wordsmith the proposal. The city planner, who had written successful proposals for the community such as one to fund roadside art, became one of the proofreaders.

Proposing Solutions to Dilemmas

On a mesogenetic scale, that is, the scale of change in the functioning of the town, the *Olympic Class Learners* proposal addresses a contradiction between the town's impoverished economic base and its sustainable future. The town of Raymond is located in Pacific County. The county's history is one of boom-and-bust economy due to the

over-exploitation of fishing and logging resources at the turn of the century. The industries have suffered further declines in recent years, affecting employment level, average income, and population. In 1997, the population of the town was roughly half that of the year 1900. Today, more than 60% of the children qualify for free or reduced-cost lunch. Yet the county continues to be heavily dependent for its economy on both natural resource based industries. In their day to day work, the teachers prepare the children for their future, but when the children graduate there are few local jobs available. In finding work, graduates repeatedly leave the town, arguably contributing to its decline. The dilemma of how to sustain the town has been apparent since the bust, and several teachers in this close-knit town feel the contradiction deeply. They often serve as caregivers for the many children whose parents are migrant workers and who have come to Raymond for inexpensive property or temporary jobs. By example, when the local hotel burned, many families were displaced, and the high school gymnasium housed the families for many weeks. Teachers gathered clothes from the community, and the school fed its new inhabitants. The Olympic Class Learners proposal served as a model mediating the community movement towards more technologically advanced activity. Alternatively, the proposal may be viewed as a *boundary object* (Star & Griesemer, 1989) between the past activity and that of the future. An excerpt cited below illustrates how economic conditions, as constraints, shape the object of the town—*seeking new industries*:

Our communities are actively seeking new industries to replace our dependence on lumber and fishing. It is highly likely that any new industries will utilize technology, and will need a skilled workforce. We will offer our students skills for the future, and encourage their parents to learn new skills by helping their

children. One component of our proposal is the establishment of "Family Research Evenings" at the Timberland Regional Library branches in Raymond and South Bend. Parents will be encouraged to accompany their children to the library and assist them with research for their classroom projects. In return, students will act as mentors for their parents, and will assist the parents in using the library's computer system. Parents and community members will also be encouraged to volunteer in the school as we work on our project. They will have an opportunity to learn about the technology with the students.

Cindy's colleagues agree that the proposal would not have been attempted if it were not for her central role. ESD 113 not only mediated Cindy's development of grant-writing self-efficacy, but also the proposal writing through the ideas she learned there. She composed several ideas, as envisioned new practices of the future (culturally advanced) community, in solution to the problem of lagging technological literacies. These ideas appear in the above excerpt, including the changing role of education in bridging to a new system of activity. These include "Family Research Evenings" and the overturning of traditional learning models in which adults become co-learners with children, and in which children mentor their parents. Reflecting on the past, she writes:

Certainly my work with the ESD strongly influenced the direction of the Olympic Class Learners grant. Some examples . . . the idea of putting computers in classrooms rather than in a computer lab; the approach of purchasing only productivity oriented software, rather than "edutainment" titles; bringing in training from Apple that followed the ACOT model; adding AlphaSmarts to the hardware purchase; purchasing a mail server and allowing elementary students to have accounts. One of the key items - the on-site staff development—was (in my memory, at least) an idea of mine that was picked up by the ESD and used in the grants they wrote (which led to my current job.) I also suggested vouchers that teachers were able to use to purchase class time at ESD 113 to fill any gaps they had. This idea was also incorporated into future grants at ESD 113.

The proposal offered creative solutions to another contradiction—between the object of future student literacy, as mandated by the state, and the actual performance in both Raymond and South Bend at that time. Each had a disproportionate number of low-achieving students. Prior to the proposal, the pattern of test scores indicated development through all grade levels, but consistently one year behind the state norm. Therefore, attention was needed at the lower grades. Consequently, the elementary schools in both towns planned to team together. The teachers decided that their literacy efforts could be embedded in learning about the continents of the world. Each classroom was assigned to a continent, and students groups were assigned across grade-level and school boundaries. Overall, the grant targeted improvements in student achievement, motivation, authentic audience, and technology literacy. Within the area of student achievement, the document maps elements between Washington state frameworks (Essential Academic Learning Requirements) and the design of the tasks to be undertaken by the school staff,

explicating in particular, *Reading with Comprehension*, *Writing with Skill*, *Communicating Effectively and Responsibly*, and finally, *Social Studies—Geography*.

Olympic Class Learners is a cross-age level, cross-curricular study of the continents. Classes will be teamed with other classes at different grade levels. For example, one team might consist of a Raymond kindergarten, South Bend third grade, Raymond fourth grade and South Bend sixth grade. These teams will work cooperatively via e-mail and electronic conferences to study the continents, and to produce web pages and multimedia presentations to publish what they have learned. The curriculum committee will work with the staff to coordinate their efforts. All staff members, certificated and classified, will be involved in the project.

A primary contradiction in instrumentation that many schools face is in the exchange-use value of computers. The economic conditions of Pacific County stress the resources that schools can provide for the children, and there is heightened determination to use every cent of the budget wisely. Seventy-five percent of the Olympic Class Learners budget was designated for technology that would significantly improve the technological capacities of Raymond and South Bend. It was considered critically important to make optimal use of the technology. AV capabilities were included on one machine in each classroom because, while computers were often not available at home, VCR's were available, and taping presentations would be a way for children to bring their work home.

Hardware: We will use a tiered approach to technology purchasing which will allow students to choose the appropriate technology for each task. Using this approach, we will purchase one AlphaSmart keyboard per student, and enough Macintosh computers to equal a ratio of one computer for every 5 students. We have chosen Macintosh computers for compatibility with our current hardware and for ease of use. One computer per classroom will be capable of AV input and output. Each classroom will also have one scanner and one networked printer. The scanner and AlphaSmarts will allow all students to be productive, even if all of the computers are being used.

One of the greatest bottlenecks on the computer for elementary age children is text entry. The purchase of AlphaSmarts eliminated that bottleneck. The AlphaSmart is a fraction of the price of a full computer, addressing the exchange-use value contradiction. AlphaSmart keyboards mostly consist of a keyboard with a small text-only display appropriate for text entry. The time it takes to download from the AlphaSmart is minor compared to the children's text entry time. The keyboards allow all students to be using technology for writing, without tying up limited desktop computer resources or having to take turns on the desktop computer. This allows the whole class to work on a project at the same time.

Consequences of the Grant

Cindy completed the final writing of the proposal, while her colleague Sandy organized other people to gather the information necessary for its completion. One stipulation of the RFP was a major problem, however—25% of the grant funding covered professional development, but teachers' salaries could not be funded by the grant. As a boundary object between the OSPI and Raymond, the RFP imposed OSPI rules,

constraining what actions could take place in Raymond. The introduction of the RFP, in other words, introduced a contradiction in Raymond between the distribution of labor and its rules. Because of her past work in Raymond and at ESD 113, Cindy was the first choice among participants for their trainer, but, by the RFP rules, her salary could not be covered through the Raymond school system. Furthermore, contracting outside agencies for professional development services exported funds that were deeply needed within the community. The solution of primarily contracting outside agencies for training was not favored.

Cindy and her colleagues found themselves in a deeper consolidation of the double-bind conditions (Bateson, 2000) that educators in poor rural communities face, in general, with adopting rapidly changing technology. The proposal instrument could solve the problem of obtaining funding for equipment, if the RFP conditions could be satisfied. But fulfilling the RFP conditions through outside contracted labor would impose yet another conflict with local values, and the problem would not be solved. Because of Raymond's isolation and limited resources, all of the double-bind conditions were met. Raymond, as a system in a double bind, could not escape. Cindy's creative solution built upon her history of participation at ESD 113, and allowed the Raymond school system to "escape the field" metaphorically, through her actions of "escaping the field." She knew of the ESD's long history of professional services, and its infrastructure for providing grant support. She arranged with the ESD to contract for staff development services on the proposal. When the grant was funded she then took a leave of absence from her job in Raymond and applied for the staff development position at ESD 113, supporting the Raymond grant. In this manner, the ESD became the mediating element in resolving the contradiction that the RFP introduced. This single, yet historically complex move of

changing jobs via a grant was a particularly notable instance of Cindy enacting a history through which ESD 113 has influenced the Raymond school system development.

The Raymond School District, South Bend School District, Timberland Library, and the Raymond Elementary PTA became consortium members for the Olympic Class Learners project, and it was funded for \$407,452 for the 1997-98 school year. The consequences include some strange ironies however. Cindy had long desired more computers in her classroom, but her solution to the RFP dilemma took her out of the classroom. During the project, Cindy worked for ESD 113 in a full-time position as a staff trainer. The year following the *Olympic Class Learners* grant found Cindy working half-time in Raymond providing elementary tech support and half-time for ESD 113 providing grant support for two grants; the TIP and the Heritage projects. In 1999 Cindy went to work full time for ESD 113 supporting the TIP project. Today, she still has not gone back to the elementary classroom, but finds herself with a new identity of enacting teacher training at ESD 113. Her life has changed considerably.

In 1997 Cindy's new job was a solution to the problem of cultivating greater technological knowledge in Raymond, but her move became permanent and introduced another irony—Raymond exported to ESD 113 their primary expert in instructional technology. Since 1997 there had been growing recognition among the Raymond staff that Cindy would be working more with ESD 113 and so her colleagues began making moves to distribute her functions and appropriate her expertise. Several teachers realized that they needed to learn more about technology to use the new equipment more effectively. Linda Brummel, one of Cindy's colleagues in Raymond, then contacted Lesley College (now Lesley University). Linda and several others arranged for the Lesley's "Technology in Education" Masters degree program to be offered in Raymond.

The financial prerequisites for the program necessitated recruiting other teachers in Raymond and the neighboring towns, including South Bend. Subsequently, 50% of the elementary teachers in Raymond participated in the program. Bill met Cindy and her colleagues on-line as an academic advisor, and later, face-to-face, in an instructor role.

Secondary artifacts, "used in the preservation and transmission of the acquired skills or modes of action or praxis" (Engeström, 1987), have been taken up by teachers in Raymond, constituting in part the systemic change enacted through the grant. In brief, the tiered model of distributing computers continues to be used, with AlphaSmart computers prevalent and in use, despite a temporary incompatibility with new desktop machines obtained through subsequent grants. Perhaps the most significant change has been the uptake, by two of the other teachers, of Cindy's practices exploring new technologies. These two teachers have formed two of at least three teams who have since successfully applied for grants, from the Bill and Melinda Gates foundation, which have provided upgraded technology and summer training. Walking into either of the two teachers' classrooms, one will find that Cindy's goal has been met in part—there are children using AlphaSmarts and desktop computers.

Several long-standing contradictions remain unresolved, however. At the time of this writing, student scores on statewide testing continue to lag, and it is thought that technology is not a solution. Furthermore, technology continues to advance rapidly, and computers in Raymond continue to grow obsolete quickly. Presently, the underlying contradiction is held at bay with continued grants; however, the grant writing teachers are due to retire in several years, and the problems of Raymond's economy and isolation may well remain.

Discussion

When Cindy enacted the "interaction" between the ESD 113 and Raymond systems, it was in part through the development of her proposal writing skills and her concept of self-efficacy in the former that enabled her subsequent engagement in the expansive activity of proposal writing in the latter. In particular, the integration of Bandura's concept of self-efficacy and its social counterpart into activity theory supports extending the notion of *activity identity* as one that crosses systems of activity. Such an extension provides in part the means for interaction across systems of activity by coupling the development of the individual to that of the institutions in which she participates. Simultaneously (and by definition), the coupling links activity on ontogenetic and mesogenetic (Cole, 1995) scales, making happen what Lemke (2000) terms "integration across timescales" (p. 283). Our examination of the development of self- and social-efficacy uncovers how the formation of these beliefs on an ontogenetic scale serves as a precondition for collective, systemic change. There is a striking complementarity between the notion of identity across activity that affords insight into collective development, and Bronfenbrenner's (1979) notion of *ecological transition*, through which the movement from one setting to another becomes a catalyst for individual development.

We further investigated how long-standing contradictions between extant and future activity—for example, the economic and social constraints of the Raymond school system and the vision of empowering children with technology—have led mesogenetic development but only after the contradiction was felt strongly at an ontogenetic scale, by Cindy. These two facets of analysis, in juxtaposition, facilitate unpacking the linkages between the two time scales and hence between the coupled development of individuals

and institutions. The expansive activity enacted in the writing of the *Olympic Class Learners* proposal was a major effort towards changing the instrumentation, practices, and division of labor, that is, systemic change, in the Raymond and South Bend school systems. The very possibility of this effort is due to many people, yet is critically dependent upon one person's belief: "We can do this." The contradictions that Cindy faced personally spurred her participation in school change. The first occurred between the dearth of computers and her deep-seated goal of putting computers in the hands of children. The second involved the notion of equality in school, which implied that all teachers evenly share available technology, even though others did not share her goal.

It is illuminating to contrast Cindy's role, bridging between the Raymond/South Bend communities and ESD 113, to that of *network coordinator* (Sarason & Lorentz, 1998). While Sarason and Lorentz outline several key elements of the network coordinator role, they have not explicated how these elements develop over time. We posit that a person's participation across systems builds her working knowledge of each system, in effect making available the cultural resources afforded by each system. Cindy's working knowledge includes familiarity with what goals people are attempting to achieve in each system, making collaboration possible by seeking synergy between them. Working knowledge of an activity system also includes a sense of what actions are possible within each system that enable what can be done when they are "brought together," as Cindy accomplished by bringing ESD 113 and Raymond together with the *Olympic Class Learners* proposal. It involves knowing the differences as much as the commonalties of each system, and understanding how the actions afforded by participation in each institution can be brought to bear to solve problems and achieve one's purpose.

Unlike Sarason and Lorentz' network coordinator, Cindy was not of independent means, but became employed by both systems, gradually moving from the periphery to greater centrality in one, and moving oppositely in the other, thereby enacting the core means through which these two systems “interacted.” In a manner similar to the network coordinator, Bronfenbrenner's notion of a person enacting a *primary link* between settings focuses primarily on social relations (Bronfenbrenner, 1979). The concept of primary link does not explicate mediation by material artifacts and tools, the role of economic conditions, or the creativity with which people link the development of institutions together. We wish it to be recognized, although outside the analysis of this article, that the writing of the *Olympic Class Learners* proposal entailed a wide nexus of people and things in space and time. The process brought together material and ideal components of several systems, at the very least OSPI, Raymond, South Bend, and ESD 113.

Taking activity to be a unit of analysis that includes both the individual and his/her culturally defined environment has been essential in understanding Cindy's professional development in interaction with the Raymond schools and ESD113. Yet a problem emerges with this choice. Adams (1996) points out the general analytic difficulties of defining what constitutes a system and its boundaries and identifies *interconnectedness* as the common criterion across the genre of systems theories. While Adams leaves the concept of interconnectedness to be loosely defined, Barker (1968) regarded a similar term, *interdependence*, and specifically used an economic measure for defining and quantifying units of interaction. Bronfenbrenner (1979) considers interconnections among microsystems (settings) in terms of qualitative relations that span across the settings, including the role participation of people, social networks, communications, and knowledge within one setting about another.

Apart from Cindy's participation with both institutions, our initial modeling of the two systems as independent is supported by the following observations. First, the frequency of interaction between the two is far less than the frequency of interactions that occur day to day within those institutions. Contributing to the isolation of the Raymond schools from ESD 113 is its rural location. Second, the two institutions are economically independent. Raymond receives the majority of its funding from the state, with local tax contributions completing the budget. Created by the state legislature, ESD 113 receives separate "core funding" from the state for a portion of its programs. ESD 113 must be entrepreneurial for the remaining programs, which includes obtaining funding from federal agencies. Third, applying the definitions of the fundamental categories of activity systems (Engeström, 1987), ESD 113 and the Raymond schools, for the most part, comprise different objects, artifacts, collective subjects, division of labor, and rules. The people of ESD 113 spend considerable time developing grant proposals and providing professional development services for schools, whereas the Raymond schools focus on teaching children. Consequently, on all these accounts, and most of the time, the two institutions are highly independent of each other, although together they have constituted a large part of the mesosystem (Bronfenbrenner, 1979) in which Cindy's development has taken place. Cindy herself enacted a large share of the interactions between ESD 113 and the Raymond schools. Her movement from the role of teacher in the Raymond schools to that of teacher trainer at ESD 113 is inextricably linked to the achievement of the Olympic Class Learners grant. Simultaneously Cindy's life trajectory and the Raymond school system were transformed through this ecological transition.

Our choice has been one of bounding the Raymond schools and ESD113 as discrete systems, yet clearly it remains necessary to account for interaction between the

two institutions. The notion of *brokering*, applied in the alternative communities-of-practice framework (Wenger, 1998, p. 109), addresses how communities interact with their surrounds, bringing information and ideas into a community, yet the issues of creative transformation and co-development in that framework remain to be addressed. Within the activity systems and ecological frameworks the qualitative and quantitative means of delineating systemic boundaries and characterizing dialectical developments have not completely accounted for ways in which simultaneous individual and collective transformations take place across the artificial boundaries of systems and times-scales. From this perspective, activity theory would benefit from improved concepts and forms for describing fresh responses to emergent, situated contradictions that draw upon past participation elsewhere as the raw material for intertwined personal and systemic transformations.

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