New Literacies at the Digital Divide: American Indian Community Computing

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This study is about a community computing lab established by a U.S. Department of Commerce grant to bridge the Digital Divide in a rural Arizona American Indian community, a project called *Native Connection* (a pseudonym). This paper describes the process of integrating new literacies associated with a high-tech computer lab into the life of a small traditional community. Cultural Historical Activity Theory frames the dynamic interconnected elements of the lab: the participants, their purposes, the tools, and the community. Data were collected via questionnaires, interviews, and participant observation over most of a year. Findings demonstrated a steady increase in attendance and acceptance of the lab as part of the neighborhood, growth in after school lab activities by youth, and the beginnings of new literacy learning by lab users.

There is a long historical precedent for uneven distribution of Information and Communication Technology (ICT). The printing press, for example, was a rare and expensive technology for hundreds of years and only recently has it become a common household tool for communications discourse in the form of a computer printer. Electricity was a parlor game for at least 100 years before the telegraph. Telephones, radios, and televisions took a generation or more to begin to penetrate the market and have become commonly available in homes and schools. There are often issues of equity in distribution and access to digital tools in communities where the economics of education have tipped the scales in favor of children in wealthier communities. According to a 2004 report, U.S. household penetration of PCs had reached nearly 80% (Research and Markets, 2004). Currently, there is rapid development of information-handling techniques to meet the potential of the World Wide Web. While the penetration in U.S. homes[1] of wireless networks, personal digital assistants, and text messaging continues to grow, these new electronic tools involve significant expense to the user and may be out of reach for many people. The resulting range of inequalities is referred to as the Digital Divide [DD] (Selwyn, 2004). The DD is the gap between educational institutions that integrate technology into education and those that do not have access to this technology—or don't have the knowledge and skills to put it to the fullest use (NICI, 2003).

Studies done by the Telecommunications and Information Administration on the DD (NTIA, 1995, 1998, 1999) showed that ICT tools were not equally available across the United States (Solomon & Allen, 2003, Wiburg, 2003). Indeed, it is a worldwide problem with long-term economic consequences; see recent efforts in Egypt, Ireland and India (Warschauer, 2002, 2003). Many factors contribute to this inequity: segregation, poverty, educational opportunities (Harper, 2003; Hoffman, Novak, & Schlosser 2000; NTIA, 1998, 1999) language, and/or culture (Freire, 1994; Moje, 2002). A factor closely related to each of these inequities is literacy. Literacy as a meaning-making process (Goodman, 1994), and a situated set of social practices (Street, 2003) is related to individuals' ability to take advantage of new electronic modes of literacy. These new literacies (forms of literacy other than reading and writing text on a page) exist for specific purposes and are used in specific settings or contexts (Barton, Hamilton, & Ivaniç, 2000; Gee, 2000; Leu, Kinzer, Coiro, & Cammack, 2004).

Objectives and Setting

In 1998, The U.S. Department of Commerce Telecommunications and Information Infrastructure Assistance Program funded the *Native Connection* project. This grant initiative was created to address the Digital Divide and programs like this were established in rural areas around the U.S. in order to bridge the gap between communities traditionally underserved by connectivity, access to the Internet, and advanced computer systems.

The Community Resource Lab (CRL) was a high-speed access computer facility established by a joint effort of the host Tribe, the local Community College and the local University (Betts, 2002).

Major desired outcomes identified for the *Native Connection* project were:

- Improved training and learning opportunities
- Enhanced K-12 educational performance
- Enhanced post-secondary educational performance

Stakeholders were hoping for improved high school retention, heightened interest in science and technology careers, on-line student services such as tutoring, and support for the development of native language communications. Many of these goals and desired outcomes were realized.

A goal of CRL was to bring new literacies to this community by introducing new tools into the activity system, and to create educational support for students and community members. This study was undertaken to examine the impact of this new technology on literacy practices in the community by observation and survey of community members who made use of the lab. The study addressed the following questions:

- How was CRL accepted and integrated into the community?
- How did CRL users attitudes toward new technologies shift over time?
- What new literacies were formed among CRL users?

The author collected most of the data for this study as program evaluator. The study focused on activities in and around CRL related to computers and use of the Internet. The tribe's education program was well established and moving toward the goal of self-determination (Deyhle & Swisher, 1991) where the tribe was making decisions internally, although coordination with the local school district was hampered by the lack of an intergovernmental agreement that would allow for the sharing of student files. Tribal educators emphasized issues of language and literacy as concerns. While many tribal members spoke three languages, they were often lacking literacy skills in any of them.

The community, which was called the Pueblo, was established in 1964 on land acquired from the federal government. The community was formally recognized as an American Indian tribe by the Department of Interior in 1978. The principal languages were English and Spanish, the latter being a language of daily use surviving from the tribe's origins in and continued contact with Mexico. The area in which the Pueblo is located has been heavily Hispanic since the period when southern Arizona was part of Mexico.

As a context, the Pueblo is a traditional community of inter-connected families. Members of the tribe began moving north from Mexico in the 1880s, settling in what is now the southwestern United States. The tribe's culture involves many religious observances that unite families and the community and often take precedence over school, among other things. CRL hours and days of operation were synchronous with the ceremonial calendar (unlike the public schools). A tension that prevailed was that young children were subjected to many, often conflicting, influences. While CRL became known as a safe place in the neighborhood and many parents became involved through personal visitations on behalf of their children, there was always a security issue; strong locks and bars on the windows were required to protect the equipment.

At the time the CRL was established upon the award of a Department of Commerce grant, revenues from the tribal casinos were bringing change to the reservation in areas such as employment, housing and education. During this transition, CRL became a focal point of tensions between the traditional tribal life and the effects of information technology emblematic of and rapidly gaining momentum in the mainstream society. Modern media forms were part of the new infrastructure that the Tribe was creating and television, the Internet, cellular phones and video games were already bridging the DD before CRL was introduced.

From a technological perspective, there was pressure on the Tribe to assume operational and fiscal responsibility for the lab once grant support ended. Under provisions of a grant agreement, the partnership with the community college and the university provided technical support and maintained connectivity. Stakeholders were anxious that CRL continue under tribal auspices when the grant expired and no longer provided financial resources.

Until 1998, personal computers were very rare on the reservation and were found mostly at tribal headquarters and the police and fire departments. Most

people who wanted to use the Internet for personal or educational purposes had to visit the nearest public library, a half-hour bus ride away. The local public schools were poorly equipped to provide computer experiences and access for students much less for the community.

The Community Resource Lab was housed in a grey portable building at the Tribe's Education Annex. A charter high school and the preschool programs were located nearby. There was a ramada and a small garden in the back yard built by local youth as a project under the direction of a tribal member who taught at the public intermediate school. Of the approximately 475 students who visited there, more than 45% were tribal members at the time of this study. Houses line both sides of the adjacent street and have chain link fenced yards. The yards are bare desert earth, hard, smooth and uneven. Immediately behind the lot a community space had been cleared expanding the area used for cultural activities.

CRL opened in 1999 with 20 PC workstations, a high speed T-1 line connection to the Internet, and a collection of software for a range of ages and interests. A delay of several months was caused primarily by the lack of a suitable building and infrastructure for such a high-end installation. The plan to have the Tribe purchase the hardware was modified to take advantage of the University's buying power and experience purchasing computer equipment. The lab supervisor reported that when she started, "They didn't have phones, so I had to go home to check on the kids—a T-1 line, but no phone." She was supported by the grant and the Tribe in earning her Microsoft certificate. A server was added for the lab later that year. Software, including educational games, and application programs were purchased, along with a camera and printing supplies. These attractive new tools would require new kinds of literacy and learning for participation (Alvermann, 2004) [see Appendices A & B for a list of software available at CRL].

Much of this community's traditional discourse was oral and there was not a strong print tradition. Many community members were trilingual in Spanish, English and the heritage language (Trujillo, 1997). However, common discourse among young people was often based on the popular media. The youth culture was shaped for many young people by what they saw on cable television or on the Web. Many youth, who did not find print texts to be valuable, were being isolated through their teachers' failure to acknowledge the value and importance of non-print based text, such as video, graphics and animation (Moje, Young, Readance, & Moore, 2000). Students felt that, in their own way, they were part of the information age. The culture and the affinity groups they formed often utilized technology to establish identity (Gee, 2000). Learning was often incidental to playing and exploring and it was difficult to quantify or attribute effects. However, a broader picture of the context can often show how skills and attitudes were transformed.

In 2003, CRL was moved to a larger building central to the reservation that also housed a new Intel Clubhouse (IC) multimedia computer lab established with a grant from Intel Corporation. The new community activity center thus added

15 new computers with multimedia capability, including a music studio and workstations for robotics, graphics, video and animation to the community's ICT resources.

Theoretical Background

New Literacies

Literacies are situated, not abstract (Barton, Hamilton & Ivanič, 2000; Gee, 2000); that is, they exist for a purpose and are used in specific settings or contexts. Literacy is multimodal as are many forms of communication (Kress & Van Leeuwen, 2001). Kress (2003) uses the term multimodal to describe literacy in the "new media age." The New London Group (Cope & Kalantzis, 2000) describe the "multiliteracies" that children readily attain in their media-rich worlds. Alvermann (2004) applies multiliteracies as supporting student discourse in science learning. Nardi (1996) regards technology itself as text in an "information ecology," where basic tenets for responsible behavior are being worked out. Gee (1998) describes the relationship in terms of technology and a "new capitalism," based on workers with flexible, computer-mediated, skill sets. The developing economy calls for individuals who bring to the workplace a variety of learning skills and experience in collaborative problem solving and creative thinking, what Gee (2003) called "shape-shifting portfolio people."

To be literate in today's society as Leu (2002) defines it means having access to the best information in the shortest time, to be able to identify and solve important problems and communicate this information. This means using the Internet to take advantage of its potentials of speed, depth and interconnectedness, and being able to use the computer as a tool for research, design and communication. (Leu, Kinzer, Coiro, & Cammack, 2004). These new literacies are necessary to be competitive in the job market (Besser & Dorr, 2001; Betts, 2003; Borgman, 2000). These multiliteracies (Cope & Kalantzis, 2000) value alternative modes of expression and representation in the new so-called post-typographic age (Reinking, McKenna, Labbo, & Kieffer, 1998) where text-in-print is no longer the sole basis for the study of literacy. The term literacy has to be expanded to encompass all the new tools for communication that are part of life. Scholars in the field of New Literacy Studies focus on the nature of literacy as a social practice (Street, 2003).

With this social-cultural understanding of literacy, its acquisition is a matter of cognition, culture, power and politics (Freire, 1994; Gee, 1996; Street, 1995). New literacies (Gee, 1998) that are required and supported by new technology represent challenges to people with low reading abilities. In addition to the lack of access, low literacy ability renders it difficult to negotiate the text-rich computer interface. Digital equity also means ensuring that stakeholders from underserved populations are active participants in the processes of envisioning and designing futures for their communities and their schools by setting culturally appropriate standards for their communities.

Young people develop into and adopt the conventions of the discourse community in which they live. Family or community discourse has its own

literacy requirements with its own unique discursive form, in this case a form that is linguistically distinct and oral. The discourse of the surrounding urban-based cultural setting is largely text-based and technical. If students are not able to participate in the discourse of that greater community they will fail to acquire those literacies needed for participating in that larger community. Students who have limited or no access to ICT may not have opportunities to acquire skills that will help them succeed in school and at work. However, even once there is access, as Robinson, Dimaggio and Hargittai (2004) found, the literacies required for full use of the Internet disadvantage the user who is less educated, accesses fewer sites for fewer purposes, and maintains fewer online social contacts. That study helped to show that access wasn't the entire answer to the inequities of the DD.

Methodology

This study used an integrated approach that included both qualitative and quantitative methods (Creswell, 2003) to determine the effects of CRL, show how the technology was used, and to find which attributes helped integrate the technology into the life of the community. Regular visits included participant observation, conversations and interviews, and videotaping examples of lab activities and participants. Survey data were collected about how people used the lab and how they felt about it. Participant observation noted activities in which users participated, actions that were performed in pursuit of their goals and objectives, and operations that were learned and used to apply new tools to desired outcomes. Survey items were designed to determine the attitudes and perceived self-efficacy of CRL users (Bandura, 1994). The degree of confidence in their abilities to take advantage of the new technology and integrate into their lives was an important determination.

Participants: Approximately 14,000 members[2] of the Tribe live in five separate communities around large metropolitan areas. The reservation community is located 14 miles southwest of a major metropolitan in southern Arizona. Approximately 6000 tribal members live in the main settlement where the tribal offices are also located.

In the Pretest sample (N-166), of registered users in 1999-2000, 87 were male and 79 were female. Thirty-seven individuals (22%) reported having a computer at home. Language preferences were: English - 84, Spanish - 2, native language - 31, English/Spanish - 20, English/ native language - 2, and 2 reported being tri-lingual in English, Spanish, and the native language. Fifty-three percent had graduated from high school. Eighty-three percent reported their ethnicity as American Indian.

Instrument: A 30-item User Registration Survey that captured demographic and attitudinal data was created and administered as part of the lab's user registration procedure. A sign-in sheet was instituted to record usage patterns of individuals who came to use the lab and to determine their purpose. During the last year of the project, a streamlined 18-item post-test survey questionnaire, based on an item analysis of the results of the pretest instrument (see discussion

Appendix C), was delivered to the lab in September 2001. All users, new and registered, were asked to complete the second survey.

The data were analyzed using a constant comparison method and organized to represent the overall experience of the lab from the points of view of the community members who made use of it. Careful attention to the qualitative data identified the salient characteristics of CRL and its place in the community. CRL was viewed as a dynamic activity system, embedded in the larger system of the community, and containing smaller systems such as clusters, classes, dyads or individuals. Data analysis reflected on the parts of the activity system outlined below and their interrelationships.

Cultural Historical Activity Theory

Data analysis used Cultural Historical Activity Theory (CHAT) as a framework. CHAT takes human activity as the basic unit of measurement that facilitates observation and analysis of complex human interactions in a dynamic setting (Engeström, 1999). Briefly stated, CHAT posits that the subject in an activity setting acts for a purpose to achieve an object or goal through mediating tools (tools that included technology and language). Outcomes are influenced by the culture of the community created, the rules that were negotiated, the roles that others played in that community, and importantly, the dialogue among these individual and groups. In an interconnected activity system any change in one aspect influences all the others. Engeström's Activity Triangle (see Figure 1) renders a visualization of these as interrelated nodes.
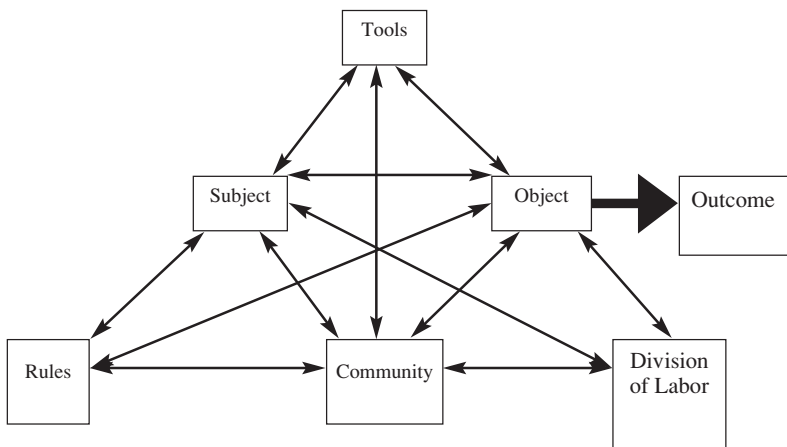

Figure 1. Activity System after Y. Engeström (1999).

It is important to add to this static diagram the dynamic nature of human interactions and change over time. Learners change as their skills grow, tool use changes with increased competency, and outcomes change as the subject and the

object evolve. Viewing CRL as an activity system allowed a focus on changes related to the introduction of new mediational tools. Activities consist of three layers: operations—such as using the mouse or keyboard; associated actions—using a program to find information; and the activity itself—using a computer for a purpose or objective. CRL became a learning activity system where individuals or groups used a variety of mediating tools (Moll, 1992). Dynamic tensions, or contradictions, at each node help to account for the changing nature of the system itself.

CRL Activity System: Activity, in this cultural-historical Vygotskian sense, includes working with others inside a system of culturally defined tools, rules, and symbols. Activity includes the needs and motives of the learners as they form and are formed by the social aspect of the setting. A complex social system, such as CRL, can be represented as a triangle, with each node representing a salient attribute of the dynamic community

This analytic tool can be applied at different levels of nested activity systems; the community, the lab, or the individual learner. CHAT provided a dynamic framework for linking related ideas such as apprenticeship, instructional design and power sharing. In addition to observations and interviews, multimedia data were collected about tools used in the lab, rules that were negotiated by the stakeholders, stakeholders themselves and their goals and motives, as well as the culture and ecology that situated the lab users and outcomes of the lab.

Findings

Interviews

Interviews with individuals, young and old, from the various groups that used the lab indicated that they were glad to have CRL as a resource. Leaders of other tribal education services like Linda F. [Director of the Tribe's Head Start program] were pleased to tell us how much they liked being able to use the lab for their children. "The kids are computer literate after coming to the program here," she said. These youngest users were growing up to expect new technologies and use new literacies. They showed their enthusiasm, tolerating headsets that were too big and a long reach to the keyboard.

Two teachers at the nearby intermediate school talked about how some of their students who lived on the reservation were benefiting from access to CRL. Both teachers were novice computer users themselves, they said, but they were aware of the new skills had come into the classroom with the students. One teacher said that he was seeing his students use the two computers in his classroom more now than before. The other teacher showed us that one of her students was now able to complete his homework more easily because he had learned to use a computer at CRL.

A group of local teachers attending a PowerPoint workshop at CRL discussed what they were learning, and how they planned to use their new skills in their teaching. They had begun collaborating to bring these new skills into their classrooms.

The lab staff described their jobs at CRL, what they did day-to-day, what it meant to them, and how they often had to help new users and learn new things all the time. They each lived in the community and mentioned how much the facility had become part of the community.

Participant Observation

This researcher made frequent visits to the lab during the high school classes and for the after school and weekend activities. Notes about what occurred, who was there, and what they did, were written shortly afterward. Some visits included videotaping, with permission, recording people using the computers and talking about what they were doing. Working with the staff, a record-keeping system for lab users was set up. Part of the participant observations included helping individuals with using the programs offered, MS Word, Excel, and Publisher. These visits also provided a communication link to the other grant principals, the University and the Community College, sometimes helping to arrange technical support.

The approximately 40 young people interviewed, individually, in pairs or in groups, were willing users of CRL. They liked coming to the lab and found it to be very useful. Most did not have a computer at home. At school they said they only got a chance to use the computer every few weeks for one 50-minute period. At CRL, through often non-structured play with as-needed help, they gained an increased awareness of the potential of the new tools. Young adults said that they were able to do projects for their job or to look for employment. Few were observed actually purchasing items on line but there was a certain amount of online window-shopping. Teachers in the tribal pre-school and the local public schools expressed their appreciation for the facility as a resource for their students. Teachers in the charter school and neighboring alternative schools that occasionally met in the CRL reported that the lab was a valuable resource that helped them keep students focused on school.

High school users included classes of students from the contract charter school nearby. They learned to use Microsoft Word to prepare their résumés. One of their teachers described how the lab was an important local resource where students did their schoolwork as they learned how to use new tools. During open lab time one girl, a sophomore, told how she used the Internet to look up the lyrics to her new favorite songs, in between doing her homework and research on the Web. A junior girl visiting the Yahoo.com site said, "I use it a lot to check e-mail." A sophomore boy reported, "I'm looking up astronomers and their discoveries." A fourth grade girl, printing an image from the web page at PBS.org, said, "I can print it out and color it in." And she showed how she did it.

Middle school age students were most visible in the after school hours. A sixth grade girl showed how she played ClueFinders™, one of a series of problem based games by Brøderbund, Inc. Four energetic boys who were regulars came to the lab after school and, with their headsets on, found their favorite music online. They searched for hip-hop and surfed to MTV. Later that afternoon, two

girls collaborated to go online to watch music videos. One helped the other with the URL. The other talked about the kinds of activities she could do, such as use the encyclopedia disk or play math games. A six-grade boy (surfing to MTV.com), told us. "I come here a lot after school." Then he showed how he navigated the complex web site and found new music that he liked.

The pre-schoolers in the Even Start and Head Start programs were regular visitors. They walked or were bused over to play math and reading games, barely reaching the keyboard. From their expressions and concentration it seemed that they enjoyed the activity very much. One of their teachers talked about how some of her students were almost independent after using the lab for two years. A teacher aide was able to describe the many operations that the youngsters were able to handle independently on the computer such as using the mouse and accessing parts of the keyboard.

Community members of all ages used CRL. They came for a variety of purposes. Some said they were looking for a job on-line in several cases or creating an agenda for a youth organization. Older residents were interested in information about government services or applying for college. Several local families came to workshops together and learned to make personalized greeting cards using digital cameras and a software program called Microsoft Publisher. As a young woman downloaded her assignment from an online college, she told us she was there because she didn't have a computer at home or at work. During one after school period, three high school boys found their favorite sites. One boy was learning to fly with a flight simulator; another was looking at the online hip-hop fashions at TribalGear.com, and the third was finding hip-hop music to listen to on line.

The lab became a part of the neighborhood. After a period of testing, parents felt that it was a safe place for their kids to spend time after school. CRL became a community resource for dealing with the world external to the pueblo, and a part of the growing community infrastructure. At the end of this study, students were saying that they were proud of their typing skills, comfortable with word processing, and felt that they gained competency in the high tech environment.

Video was recorded, and additional data in the form of charts, pictures, text interviews, questionnaires, inventories, findings and analysis were included on a CD-ROM. This multimedia document was created to illustrate the development of CRL and its role in the community. It featured the communities of learners: various youth, adults, teachers, and staff who were parts of the activity system. The primary audiences were the tribal leadership and the U.S. Department of Commerce, the granting agency. Distribution of the disk itself was restricted by agreement.

Registration and User Surveys
Almost one quarter of the people living in the community had used the lab and registered during the three years of this study. CRL procedures required staff to

ask first time users to complete a questionnaire (see Table 1, below). The first form had 30 items and many users needed staff help to complete them. A shortened version of the questionnaire was administered as a post-survey in 2002. The post-survey sample as of February 2002 consisted of 94 lab users (47 male and 47 female), ranging from age 7 to 56. This was approximately half the pre-survey sample with the same gender ratio. The average age on the post-survey was 18.5 years, down from 21 on the pre-survey. Seventeen percent reported that they had a computer in their home on the post-survey compared to 22% on the pre-survey. Eighty-three percent of the post-survey group had completed high school, compared to 53% of the pre-survey sample. A higher percentage of the earlier users were native language speakers. Over 18 percent said they spoke their native language on the pre-survey and only one person reported that s/he spoke the native language on the post-survey. Just over 50 percent (84) on the pre-survey said they spoke English. This was fewer then reported by Trujillo (1997) who found in her larger survey of this community (N=1872) that eighty percent of the men women, young and old spoke English. Seventy-five percent of the post-survey sample self-identified as American Indians, compared to 83% of the pre-survey sample. Twenty-seven percent of the post-survey sample wanted the lab to be open 24 hours, 7 days a week (this was a new item on the post-survey).

Table 1
Sample Demographics

	Pre N=166	Post N=94
male	87	47
female	90	47
PC at home	22%	17%
h.s. grad	53%	83%
Native Language	English 84	English 62
	Spanish 2	Spanish 1
	NA 31	NA 1
	E/S 20	E/S 22
	E/NL 2	E/NL 11
	E/S/NL 2	E/S/NL 11
Avg. Age	21 range 2-59	18.1 range 7-56
id N.A.	83%	75%

T-Test

A paired (dependent) t-test was performed to compare the means of the 18 questions asked on both the pre- and post-test surveys (see Appendix C). Mean differences were found in the results of eight items, which suggest that the attitudes of the subjects toward computer use, in particular for communication, showed a positive change between the time of pre- and post-survey assessments. The items that showed significant change concerned electronic communication and the new tools participants had for obtaining and sharing information. Each

item response was a choice on a five-point Likert scale from *strongly disagree* to *strongly agree,* with a rating of five indicating highest agreement.

4. I enjoy using the computer to communicate with my classmates. (Pre 3.32, Post 4.14, Mean diff.= .83. SD 1.765. p=.000)

5. I enjoy using the computer to communicate with my teachers. (Pre 3.04, Post 4.10, Mean diff.=.96. SD 1.675, p=.000)

13. Using a computer gives me more chances to practice English. (Pre 3.62, Post 4.03, Mean diff.=.41. SD 1.517, p=.000)

14. E-mail helps people learn from each other. (Pre 3.55, Post 4.25, Mean diff.=.70. SD 1.626, p=.023)

15. An advantage of using e-mail is you can contact people any time you want. (Pre 3.85, Post 4.21, Mean diff.=.35. SD 1.382, p=.000)

16. Writing to others by e-mail helps me develop my thoughts and ideas. (Pre 3.39, Post 4.28, Mean diff.=.89. SD 1.601, p=.023)

17. Using e-mail and the Internet makes me feel part of a community. (Pre 3.40, Post 4.09, Mean diff.=.69. SD 1.746, p=.000)

18. Using the Internet is a good way to learn more about different people and cultures. (Pre 3.86, Post 4.33, Mean diff.=.47. SD 1.663, p=.014)

The incoming attitudes of participants toward the lab and technology were already generally positive. Their experiences in the lab reinforced their attitudes. The other questions did not show any significant change between these two assessments, indicating that the participants already had positive attitudes toward computer use and had kept the same attitudes throughout the duration of this study.

Discussion

The dynamic CRL activity system described here evolved in many ways from its inception. It was a nested system, situated within a community and a neighborhood and, in turn, containing activity systems within it. Influences from CRL experience can be tracked across various activity settings and institutions. Every aspect that we examined showed change over the time of the study. Based on a determination that human activity was the basic unit of measurement (Leont'ev, 1978; Rubtsov & Margolis, 1996; Vygotsky, 1978), observations were assigned to the seven activity triangle nodes that Engeström (1999) describes (see Figure 1 above): subject, tool, object, outcome, rules, culture and roles.

Activities, Actions, and Operations

These are structural units of human behavior, and, accordingly, appropriate units of analysis for the activity system. Starting with the broader idea of activity in the lab, users were engaged in goal-directed *actions*, [using CRL, the PCs, creating a résumé] carried out for particular purposes [to learn computer skills, learn new songs, do homework] under particular conditions [on a reservation, on

the Internet, in an open-lab setting] and with particular technical means [using PCs with Internet and various other application programs].

The *operations* learned [using the software programs, using the mouse] were both mental [learning new software] and behavioral [rule-governed], and varied with both subjective and objective conditions [attitudes, perceived self-efficacy/software difficulties, hardware failure] and means [expectations, experience/ability, interest]. Operations themselves become automatized. When operations became automatized, the subject was allowed to focus on higher skills, or actions, which incorporated the earlier operation.

Activity System: To describe CRL in CHAT terms: the *subject* has agency, that is, he or she effects, via a mediating *tool*, a goal or *object*. The subject can be an institution, a group or an individual. The tool can be language or a computer. The object can be learning, recreation, creating. The subject's agency happens in a context, a community is formed, with evolving *rules*, and possible *roles*. The outcomes can take many forms, reflecting the dynamic nature of the activity system. The tensions, or contradictions, observed in each node helped us gain some understanding of how CRL evolved into its role. These tensions and efforts toward their resolution drove the evolution of CRL, as new conventions were invented to accommodate the new tools in the traditional culture. These, "inner contradictions…" are "…the principle of its self-movement" (Center for Activity Theory and Developmental Work Research, 2001).

Subject: The subjects, on one level of our CRL analysis, were the individual users, the young people and adults, both those relieved to have local Internet access and those new and nervous around any technology. Subjects could be the students, parents, community members, or staff members. Some local organizations also occupied that role when they used the lab to achieve their goals and purposes, as did the greater community—the Tribe.

Each subject brought a history of expectations, educational experience, and technological expertise (or the lack thereof) with them, and each contributed to the culture or community of CRL. Over the three years of the study, a pattern of use showed growth in use among the under-18 age group. Over the two years, the average age of the CRL users went from 20 years to 18.5 years.

On another level of analysis, CRL itself was the subject. Its goals involved building bridges to connect the community to the Internet and the world of computer-mediated communication. CRL existed in the context the community, and played several roles. It served other branches of the tribal government, including the Tribe's police department, casino, and other government offices that used the lab for personnel training. In addition to its own internal rules, CRL was regulated by the rules set by the tribal community. Hours of operation, access and staffing were decisions made by the tribal leadership, particularly the Tribal Department of Education. In this broader view, the contradictions of the new technology and the old culture created a tension. New technologies intensified the need for the Tribe to respond in new ways to make contact with the outside, off-reservation world. With that engagement, as community members learned

new ways to use the technology, more skills and equipment were acquired to meet the growing needs for ICT.

Object: Each subject, individual or entity, had an objectified personal or bureaucratic goal or purpose for participating in the activity system. Some objects were directly concerned with learning to use CRL and its tools; some individuals were using CRL to meet outside goals. Most objectives were parallel and coexisted easily, although others did not.

The object(s) of the student users in the after school, free lab time was typically recreational, related to popular music and fashion, games, and basic research. Achieving the object involved using a mediating tool such as e-mail or the Internet, and was motivated by a desire to make contact with the greater popular culture. Many students who used CRL as a classroom were motivated by the novelty of the lab and a wish to learn new skills. Some youngsters felt that surfing the Internet and listening to popular music was a good use for the lab. Some elders did not see that as appropriate and pushed for more regulated lab use and educational activity. Some users visited inappropriate adult web sites and that led to consequences when staff discovered what they were doing. That tension led to more rules and restrictions but ultimately it was understood that it was important for the younger users to have some degree of free access. Each object was in dialogue with other factors in the systems. In this way the objective for each subject changed as their ability to use new tools changed the possible goals and outcomes.

The CRL as object was established to address the DD, which as a concept may have not been particularly useful, given the constant diffusion of new media and new literacies into a traditional culture from a surrounding dominant culture. CRL was not the sole source of new literacies in this community.

Tools: CRL itself was a tool for the community members to bridge the DD (Betts, 2002). The CRL and the particular tools therein mediated the efforts of the subjects (users) to reach their object (digital parity). The initial inventory of the CRL grant showed a lab that was well equipped technologically. However, its impact was delayed more than a year due to lack of a suitable building with adequate power and security and it was dependent on the Tribal Education Office for basic office supplies, printer paper, disks and the like.

Once up and running in a new portable building, CRL offered workshops on basic computer skills and software programs. Several Department of Education programs were supported in its regular schedule with appropriate software and the lab staff. CRL provided open lab time for tribal members to access and explore the Internet and various software programs and applications. This made it possible for individuals to learn how to use new tools and begin to discover what the potential was for them.

Users' levels of literacy dictated to a significant degree efforts to reach across the Digital Divide. This was an important observation. There was a tendency to only use certain technology tools. There were many software programs that were not used (See Appendix A for a listing). Many of the

capabilities of the lab and its network were not used, such as server-side software and client storage. During the after-school hours, we saw school aged users visit MTV.com and other adult pop culture websites regularly.

Students said that they found it useful to practice typing and to use the word processor for schoolwork at the lab. This created authentic literacy experiences for those who were learning to use written language. Some of their teachers attested that the access to the lab was associated with improved performance in the classroom.

Rules: Establishing the rules of the lab was a process that involved the behavior of users, perceptions of parents and elders, permitted activities, and policies related to hours of operation, restricted web sites, and the need for Net Nanny (an Internet filtering program). As mentioned above, infractions that grew out of what we can call increased sophisticated Internet use were consequated. Generally the trend was toward increasing restriction, with more specific regulations put in place as users gained expertise and began experimenting.

For one example, it was found by trial and error and some confusion and heartbreak on the part of some young people, that many chat rooms were not appropriate for an educational setting. One young lady who had been visiting a chat room exclaimed, "He said he loved me!" Individuals, and the CRL staff, learned that there were people in chat rooms who were not to be trusted. This tension between the value of using the Internet as a source for information and the need for young users to learn critical thinking in the unmonitored world of information on-line was resolved by putting a list of "off-limits" chat rooms up on the wall.

The lab's hours of operation were flexible. It varied by season, by demand, and by availability of tribal funding for staff. There were often regularly scheduled class times and, with few exceptions, there was always open lab during after-school and evening hours. The daily schedule reflected the community's religious practices and there were closings for holidays and ceremonies. The post survey showed that many community members who used the lab would have preferred to have it open 24 hours a day seven days a week. This was a built in tension that was resolved in several different ways.

Division of Labor (Roles): The system's division of labor consisted of the formal roles of the lab supervisor, lab aides and teachers who brought their classes to the lab. Of course there were the users, young and old, who were the customers. At first users relied on the lab staff for help and direction, but they were quick to learn the basic navigation skills needed to use the Internet and the basic tools such as word processing that were available. Students who used the lab in the after-school hours often assumed mentoring roles with their peers. The roles of the lab supervisor and the lab aides evolved and varied as the effects of frequent personnel changes at all levels were felt in the lab.

During this study there were several changes in the Department of Education administration. There were three Directors of Education at the Tribe, and for a period, none. The second lab supervisor, who had been Microsoft

trained and certified as part of the grant, was dismissed in the second year of the study.

When the Head Start and Even Start classes came for their weekly sessions, the lab aides supported the teachers and helped with these very young lab users. When the charter high school used the lab for projects, the lab aides tended to withdraw somewhat and let the teachers handle the older students. During the after-school hours, the lab aides supervised behavior, assisted with application programs and monitored the screens for appropriate use. Several parents noted that they were pleased that CRL occupied their kids productively for a few hours after school.

Technical support for the lab came from the University and the Community College. The Tribe's Information Technology office did not begin to provide services until the very end of the grant period. The lab was dependent on the grant and graduate students from the university to install software and hardware upgrades in the lab, and for establishing and maintaining connectivity. This was a tension in the activity system regarding the question of the Tribe supporting the lab when the grant expired. The resolution to this tension was positive but the tension was real.

Community: CHAT emphasizes the social aspects of activity systems over the role of the individual. The CRL community was influenced by its context, a small American Indian community near the Mexican border. The atmosphere of CRL was patterned on similar settings elsewhere: school computer labs and public computer labs offered by the county library system in the larger urban area off the reservation. The CRL community was made up of the people who as subjects shared objectified goals. The community of learners (Campione, Brown, & Jay, 1992) at CRL shared in the establishment of social values, respect, appreciation, cooperation, and negotiation, while respecting the levels of authority and sharing understanding of the technology tools. Its rules, as discussed above, gave it structure and restricted personal freedom of behavior. CRL was open to tribal members. Staff was trained to help with software and hardware use and worked to maximize the effective use of the equipment

Outcomes: Although younger students said that they were proud of their new typing word processing skills, and older students expressed a sense of competence using e-mail, the Internet and creating documents, it was not possible to track high school grades and retention to show a direct causal connection with the lab (due to lack of an Inter-Governmental Agreement such data could not be shared between the tribe and the local school district). However, many high school, college and professional-level students took advantage of the lab for homework and other school-related activities.

New literacies, as Gee (1998) and others describe, were discovered, invented, and adapted for CRL and the new media age it represented for the community. The data showed, by increases in attitude and perceived self-efficacy measures of CRL users, there was an increased appreciation for the new communication and information gathering capabilities in their community and

an increased confidence on the part of users in their own ability to use the new computer-based tools. Observations over time recorded users of all ages mastering new skills and literacies. There was an increase in training and learning opportunities for tribal members. Teachers commented that their students' work had improved due to their work in the lab. Public Internet access was provided in the community for the first time.

Each subject's outcome was different. During the after-school lab hours many students used the lab productively, becoming comfortable using PCs, learning and playing games, and finding and learning their favorite popular songs. Most children were not able to create artifacts during independent lab use. Early experiences with individuals overloading the printer and using up the allotment of paper had resulted in restrictions. Many got free-mail accounts, such as Yahoo and others, and used them to communicate with friends. Classes that utilized the lab, such as the charter high school and the Head Start program for example, produced artifacts with integrated text and graphics, such as résumés and business letters. Some students showed off their work and talked about how the lab helped them with school.

Older users were more likely to be product oriented. Adults used the lab for professional development and for writing projects. The newly formed Tribal Youth Council used the lab as an office to prepare its agendas and announcements on the computers. The tribal police used CRL for training in Excel and MS Office, as did the casino and the human resources office. Several summer programs were offered for community members. Families came to take workshops together on Saturday mornings. One yielded personalized Christmas cards with digital family portraits.

The desired outcomes for the lab were clearly defined from the beginning of the project: to improve training and learning opportunities for tribal members, to enhance educational performance, and to provide Internet access. There were goals, new computer-mediated native language programs for example, which were not met during this study, though the need was there in the community for language renewal and revitalization.

Tensions: In each of the nodes described in this activity system there were tensions or contradictions. Tensions existed naturally between the old and new tools, especially new tools that require very different behaviors and open many new pathways. The rules were negotiated and changed based on new needs for establishing a safe, cooperative setting. The division of labor, that is, the roles and authority of workers, and the freedom with which users could do as they like in the lab setting, was occasionally contentious. There was also tension between the highly individualized goals and desired institutional outcomes. For example, the traditional tribal culture was often at odds with the influx of new ideas from a larger society in which the Tribe exists. The traditional and popular cultures were contending for the attention of the young people. In some cases, surfing the Internet for hours late at night was in conflict with the all-night ceremonies that were part of traditional culture. In another example, tribal elders reported that

some younger members were found to be watching sports television in a van during tribal ceremonies. Future acceptance of new literacies and new technology in the community was determined by how those contradictions were resolved. Since it is a dynamic system, this process of tension and resolution is ongoing.

Future Research

One can suggest that a tribal or collaborative research effort (Harrison, 2001) be made to follow up on this experience of community computing and find ways to continue its good effect to make it pay off for young people. Case studies based on the initial cohort of families and children identified in the initial study may show the directions that the new literacies have taken in students' lives. With CRL and new Intel Computer Clubhouse as a permanent part of the community, the Tribe has been in the forefront of rural American Indian technology infusion. It is anticipated that the dissemination of this tribe's experience will help other small rural communities that are interested in the possible effects of high technology on their communities.

A longitudinal study of the impact of CRL and the new IC on community literacy and school success might address these questions, among others:

- What do parents and family members report as the effects of a neighborhood computer lab (CRL/IC) on school attendance, school success and literacy on the reservation?

- What cultural considerations are made to accommodate native life styles? What new kinds of literacy are being developed? How are they distributed among the community members?

- How these new literacies become instrumental in the classroom?

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End Notes

[1]Consumer Electronics Association (http://www.ce.org/Research/).
[2]*Arizona Citizen*. "Pascua Yaqui: Silent no more." October 9, 2002, p. 1.

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APPENDICES

Appendix A. CRL Software Library—2001

Learning Games
Sesame Street Deluxe Series
The Learning Company: Reader Rabbit Reading 1 & 2, Writing and Creativity
     Reader Rabbit Reading Development Library *
Clue Finders
     3rd thru 6th Grade Adventures *
Jumpstart: Preschool, Phonics, and Artist
Where in the World is Carmen Sandiego? CD-ROM *
Dr. Seuss CD-ROM: Green Eggs & Ham, Cat in the Hat, Dr. Seuss' ABC
Thinkin' Things—FrippleTown
Bailley's Book House
Blaster Learning Series: Math Blaster, Science Blaster, Spelling Blaster, and
     Reading Blaster *
Super Tutor Vocabulary, Spelling and Grammar
Imagination Express: Destination: Ocean
Space Academy GX-1
Virtual Labs—Electric City

Application programs
Microsoft Office 2000 *
Kid Pix Deluxe—application program *
PrintMaster—application program
Kid Works Deluxe application program *

Instruction
Kaplan Higher Score SAT & ACT and GMAT*GRE*LSAT
Math Advantage Middle School
Math Advantage High School
Learn Office 2000 package: Word, Excel, and Access *
Learning Windows 98 *
Learning 2000—Stand-alone educational program

Added to Software Library 2002

3D World Atlas and Almanac
A.D.A.M. The Inside Story
Amazon Trail II Ages 10-16
American Heritage Talking Dictionary
Big Thinkers 1st Grade
Body Works 6.0

Candy Land Adventure Ages 3-6
Casualty Kid on the road to First Aid Ages 8-Adult
Compton's Reference Collection
Curious George Comes Home Ages 3-6
Furby Ages 4-7
I See Sue. The T Rex Ages 4-7
The Little Mermaid
Math Invaders Ages 9 and up
Mr. Potato Head Activity Pack Ages 4-8 *
Multimedia Spanish
New Millennium Children's Encyclopedia 2002
Pre Calculus
Reader Rabbit Interactive Reading Journey Ages 3-6 *
The Princeton Review—Word Smart
Reader Rabbit's Kindergarten Ages 4-6 *
Reader Rabbit's Reading 2 Ages 5-8 *
Treasure Math Storm Ages 5-9
Richard Scarry's Busytown Best Activity Center Ever
Schoolhouse Rock America Rock
Talking Typing Teacher *
Schoolhouse Rock Exploration Station Ages 6-10
Tonka Construction
Webster's History
Webster's Science
Webster's Millennium 2002 Encyclopedia
Winnie the Pooh and the Honey Tree Animated StoryBook *
Writing Tutor
100,000 Web Images Collection
Business Card Maker
Complete CD Maker
Deluxe Wills and Trusts
Desktop Publisher *
Forms Maker and Filler
Label Publisher
Learn Microsoft Office 2000
Learning Office XP
TaxACT/Desktop Assistant Bundle
Quicken Financial Planner QuickPlan Edition
Learning Windows 2000
Learn Windows 98
Learn Windows ME
Learning Windows XP
Mavis Beacon Teaches Typing
McAfee VirusScan 4.0

Nuts & Bolts 93 Deluxe
PC Attorney
PrintMaster 7.0
Professional Resume Plus
Quicken 2000 Deluxe
Quicken Family Lawyer Deluxe 2000
Home Depot Home Improvement 1-2-3
Healthy Cooking
Precision Street Maps USA
National Geographic Photo Gallery
Mosby's Medical Encyclopedia

* most used

Appendix B. Web resources posted on the walls—April 2002

Search Engines
www.yahoo.com
www.yahooligans.com
www.webcrawler.com
www.infoseek.com

Homework help
www.eplay.com/homwork/
www.brainpop.com
www.afterschool.com
www.cbc4kids.ca
www.ash.udel.edu/ash
www.EnchantedLearning.com/school/index.html
www.washingtonpost.org/kidpost/
www.wvpubcast.org/ homework
www.discovery.com/stories/skinnyon/skinneyon.html

Other
www.4kids.org
www.disney.com
www.coloring.com
www.beaniebabies.com
www.zainybrainy.com
www.family.go.com
www.sesamestreet.com
www.foxkids.com
www.comics.com
www.safesurf.com
www.acekids.com
www.scholastic.com
www.whitehouse.gov
www.child-safe.com

Appendix C. Factor analysis: Creation of the post-survey and item analysis

Of the collected pretest surveys, 240 were used for statistical analyses. The pretest contained 30 items. In order to reduce the length of the survey for the posttest survey, an exploratory factor analysis using squared multiple correlations as prior communality estimates was conducted in order to identify the number and nature of the factors underlying the data . Only 146 entries went into factor analysis due to missing values. The principal factor method was used to extract the factors, and this was followed by a Varimax (orthogonal) transformation. A scree test indicated 7 meaningful factors, so these factors were retained for rotation.

Items yielding a factor loading of .45 and higher are considered to load on a particular factor. Thus, 10 items were found to load on the first factor, which was subsequently labeled as "computer use" factor. Five items loaded on the second factor, and was labeled as "communication" factor. Three items loaded on the third factor, which was labeled as "community" factor. Four items loaded on the fourth factor, and was labeled as "negative computer use." Two items loaded on factors 5 and 6 while three items loaded on factor 7, and they were labeled as "e-mail," "writing," and "negative writing on computer" respectively.

After the factors were identified, coefficient alpha reliability estimates were obtained for each factor. Reliability estimates were:

Factor 1= .89,
Factor 2= .71
Factor 3= .79,
Factor 4= .75,
Factor 5= .56,
Factor 6= .68,
Factor 7= .61.

Of the seven factors, Factors 1, 2, 3, and 6 were included on the post-survey. Factor was excluded because it contained negative statements, while Factors 5 and 7 were dropped because of low reliability estimates.

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