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ABSTRACT

This paper examines themes from a cross case analysis of the Buddy System Project, a program that loans students and teachers in selected elementary classes in Indiana a networked home computer and provides schools with additional classroom computers. Qualitative data were collected from 28 homes and 19 classrooms at 4 participating schools. The three themes examined are the impact on the school's learning environments; the impact and use of the telecommunications functions; and the impact of home computers on the home environment. Buddy was considered a success in all of the schools. Computers were used extensively, and teachers noted that the project had a renewal effect on their careers and a positive impact on the culture of the classroom. They also reported that the majority of their current class computer activities were only possible because there were computers at school and at home. The Buddy home computers contributed to a general dissemination of computer knowledge. Teachers and parents reported that the written format of the electronic communications functions had a positive influence on students' reading, writing, and typing proficiency. A significant factor in successful implementation was the presence of innovators, i.e, teachers or administrators ready to take chances and lead the way for others. (Contains 17 references.) (KRN)

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Computers Extending the Learning Environment: Connecting Home and School

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Abstract

Qualitative data were collected from 28 homes and 19 classrooms at four schools participating in the Buddy System Project. Buddy loans each student and teacher in selected elementary classes a networked home computer, and provides the schools with additional classroom computers. In this paper we examine three themes from the cross case analysis: the impact on the schools' learning environments; the impact and use of the telecommunications functions; and the home computers' impact on the home environment.

Buddy was considered a success in all of the schools. The computers were enthusiastically received and were used extensively. There was high use of tool-based software that permitted the students to generate and process information, and a minimum use of the computer for rewarding behavior or for rote instruction. The teachers noted that the project had a renewal effect on their careers and a positive impact on the culture of the classroom. Teachers also reported that the majority of their current class computer activities were only possible because there were computers at school and at home. The home computers allowed the students to practice and explore at their own pace and permitted teachers to assign more involved projects.

The Buddy home computers have contributed to general dissemination of computer knowledge. Students entering the program are increasingly familiar with the Buddy computers and software through friends and siblings. Parent noted that their child and the home computer helped them feel more comfortable with computer technology and terminology.

Teachers and parents reported that the written format of the electronic communications functions has had a positive influence on the students' reading, writing, and typing proficiency. Students often preferred spending time on BuddyNet or Prodigy to watching television. Teachers reported several cases of quiet students who blossomed on e-mail, initiating communication through extensive e-mail messages.

A significant factor in successful implementation is the presence of several innovators; teachers or administrators ready to take chances, work at the cutting edge, and lead the way for the others at the school. In addition, the success of the program would not have been possible without a large amount of extra effort on the part of the teachers. All the teachers reported spending long hours learning about software and trying to "keep up with the students." In all cases the teachers reported that the effort was well worth it.

Computers Extending the Learning Environment: Connecting Home and School.

What gateways to learning open when the homes and classrooms of over 2000 students in 20 selected elementary schools are connected by networked computers and e-mail? This study examines qualitative data collected from 28 homes and 19 classrooms at four Buddy System Project schools to provide answers to that question.

Buddy equalizes access to technology by loaning each student and teacher in selected Indiana elementary classes a home computer, modem and printer. It also provides the schools with approximately one computer for every four students in the classrooms. In addition, it seeks to expand the time and space of the learning environment by linking all the homes and schools through electronic mail, computer bulletin boards and a "chat channel," and providing participants access to a commercial informational network such as *Prodigy* or *US VideoTel*.

In this paper we will examine three themes from the cross case analysis: Buddy's impact on the schools' learning environments; the impact and use of telecommunications functions; and Buddy's impact on the family learning environment. These sections are preceded by an overview of the Buddy System Project, an abbreviated literature review, and a methodology section.

The Buddy System Project

The idea for the project arose in 1987 when members from the private sector working with the Indiana Corporation for Science & Technology, met with H. Dean Evans, Indiana Superintendent of Public Instruction.

> Addressing such issues as education in the Information Age, changing work force skills, demands on telecommunications infrastructure, and Indiana's competitiveness in a world economy, the group created what has been described as the most innovative educational project in the nation today (The Buddy System Project, 1991, p. 1).

The long-range vision of the project is to extend the learning experience beyond the classroom by placing a networked computer in the home of every fourth- through twelfth-grade student in the state. The project seeks to equalize access to technology for children of all socioeconomic backgrounds.

Integrating a tool-use approach to computers into the curriculum is another of Buddy's goals. The project emphasizes teaching students to use the computer as a tool to construct knowledge. In order to encourage this approach, the project supplies tool software such as word processing and graphics programs and conducts teacher training in constructivist computer uses and learning strategies, in addition to providing technical support. The project's major objectives fall into three categories. These include improving student skills, increasing parental and family involvement in education, and providing foundations for life-long learning.

The program piloted in the fourth grade of five schools in 1988. By the 1991-92 school year, nearly 2,000 fourth-, fifth- and sixth-grade students in 20 schools were participating in the Buddy System Project. While the pilot sites were funded predominantly by the project's grants, additional sites were funded by a

cost-sharing plan. The latter plan was based on a commitment of 40% from the school district and 60% from the State of Indiana. Funding for 1991-92 included $1.5 million of state support.

A central office provided technical and instructional design support to the schools. A help line was available to all participants for any technical problems. Teachers received a stipend for their participation and were provided with computer equipment in school and at home. Further instructional support was provided through spring and summer orientation prior to fall implementation, source books, monthly workshops and newsletters, as well as periodic school visits by site coordinators. Training emphasized that teachers were not to teach a separate computer class, but rather to integrate computers into the regular curriculum.

While the central office was designed to provide technical and instructional design support to help schools attain the objectives listed above, the emphasis of the program was on site-based implementation. While the five pilot sites were adopted by either IBM or Apple, successive schools were allowed to select their hardware platform and software applications. Schools have selected IBM, Macintosh, Apple IIGS or Commodore Amiga computers. Software applications selected included various word processing, spreadsheet, graphics, and communications programs as well as a range of computer-based instruction programs (CBI). Each school also determined the configuration of the computers. Some classes pooled all of the school-designated computers and established a lab. Others opted to divide them among the participating classes.

Telecommunications

Each classroom and home in the Buddy System Project has access to a variety of telecommunications functions. These functions are provided by two different services. The first service is BuddyNet, a wide-area network that was used exclusively by Buddy participants and their families. This service used a switched-data network to connect all participating sites. BuddyNet provided a variety of modes of communication including: one-to-one and one-to-many asynchronous delayed-time messages via electronic mail (e-mail) and bulletin boards; and one-to-one or many-to-many synchronous real-time communication via private and general chat channels.

A commercialized information service, either *Prodigy* or *US VideoTel*, was the second function available. These services provided access to educational games and simulations, dictionaries and encyclopedia-like data bases, as well as current news, entertainment, sports, and weather information. *Prodigy* also allowed the user to access a nation-wide network for e-mail and bulletin boards.

Literature Review

Meta-analyses of computer research (Clark, 1983; 1985; Kulik & Kulik, 1987; Roblyer, Castine, & King, 1988) contend that the majority of studies which attribute learning gains to computer-based learning environments are confounded by covarying and uncontrollable factors. There are two primary faults found in most of these studies. The first is that the studies did not sufficiently separate the medium from the instructional method, the design effort invested, and the content. Second, studies did not sufficiently account for novelty effects. One meta-analysis of computer research (Kulik, Bangert, & Williams, 1983) found that studies lasting four weeks or less had almost twice the treatment effect as studies lasting between

four and eight weeks, indicating that novelty is a major confounding factor in this research.

There is a need to supplement the outcome measures of standardized tests with observations of the learning process. In this way, instead of determining whether computers influence learning, we gain a better understanding of *how* the computers influence learning. Qualitative research strategies offer a preferable approach to understanding how computers are used. In addition, the researcher needs to be cognizant of how the use of the computer interrelates with the social dynamics of the learning environment. Pedagogically sound classroom computer use depends greatly upon the teaching style employed. Naturalistic, field-based observational techniques provide a useful approach to describing different teaching styles and their relation to various classroom outcomes.

Field-based observational techniques were used in a study conducted to understand the impact of the computer on classroom organization, teacher-student relations, and curriculum (Mehan, 1989; Riel, 1989). In this study, four elementary school teachers were each given one Apple II computer for their classrooms, and their classrooms were observed over the course of a year. The researchers found that the teachers fit their use of the computers into existing temporal and spatial classroom organizational practices. Cooperative student interaction increased, however, when teachers, seeking to maximize time on the computer, had students work in pairs instead of individually. The major conclusion of both articles from this study was that classroom organization and computer use are mutually influential.

Another project, Apple Classrooms of Tomorrow (ACOT) is striving to document how instructional innovations emerge in high computer access environments. ACOT sites have high computer access, readily available technological peripherals such as video discs, and an emphasis on using technology as a tool to construct knowledge. ACOT has emphasized local site design and control of the high access environments. The project did not implement a standardized program of computer use, but encouraged teachers to develop new curricula and teaching methods in order to fully utilize the high computer access in a constructivist manner.

Teachers were provided with considerable technology support, but were not provided with support for effective change in the curricular areas. ACOT evaluators began to realize that teachers were likely to view technology resources as they viewed other instructional materials; as additions to their existing repertoire of curricular activities instead of catalysts of constructive student work.

> We suspected that the omission of a strong curriculum component in the majority of these technology projects could increase such risk. To explore this possibility, we contrasted technology functions in two sites that differed in the extent of their integration of curriculum design with technology planning (Gearhart, Herman, & Whittaker, 1991, p. 4).

Observations indicated that although the tools of experts (in this case word processing applications) were used in the classroom, they were not necessarily employed as experts would have used them. For example, while all the teachers reported that students were more motivated to write using the word processor and were proud of their professional-looking products, not all of the teachers were using the word processor to support the expert's process approach to writing.

Thus, while students were learning to use an expert tool, they were not necessarily learning to write as experts write; i.e., reworking compositions for clarity and using writing as a way of learning.

This study indicates that researchers need to examine more than just the tools that are used in the learning environment. In order to better understand computer use in education, there is a need to explore the ways in which the variables of software, instruction, and student combine. It is not enough to document that teachers and students are using tool applications, researchers needs to understand how these tool applications are used within specific contexts.

Methodology

These qualitative case studies were based on naturalistic inquiry. Underlying axioms of naturalistic inquiry include the beliefs that:

- Realities are multiple, constructed, and holistic.
- Knower and known are interactive, inseparable.
- Only time- and context-bound working hypotheses are possible.
- All entities are in a state of mutual simultaneous shaping, so that it is impossible to distinguish causes from effects.
- Inquiry is value-bound. (Lincoln and Guba, 1985, p.37)

Belief in multiple realities shifts the focus of research from prediction and control to understanding some level of the complexity of the situation. Thus, these realities must be studied holistically and within context. This approach relies on "thick description" (Geertz, 1973). The rationales for this type of approach can be found in contemporary methodological writings on case study such as Donmoyer (1990), Eisner (1991), Geertz (1983), Lincoln and Guba (1985), Merriam (1990), and Stake (1978).

Because of time constraints a typology was established to set boundaries for the study that included:

- Human interface with the technology: What are the typical uses by students, teachers and families?
- Pedagogy: What's the relation between teaching style & computer use?
- Organizational structures: Have hierarchies shifted because of the project?
- Personal efficacy: What are low, average and high ability students accomplishing within this project?

Starting from this typology, the research became a dialectic between foci and emerging themes that the participants identified as important, such as increased learning motivation, parent/teacher communication, and a tool-use approach to instruction. Other poin of repeated discussion included the role of the telecommunications functions, the students' increased self-esteem, and changes in the student/teacher relationship. This report was prepared to provide an understanding of three areas:

- Buddy's impact on the school learning environment,
- Impact and use of the telecommunications functions,
- Buddy's impact on the family learning involvement.

Selection of Sites

Constraints of time and money dictated that the study be limited to four of the 20 Buddy schools. Realizing that each of the sites had a unique story to tell, we understood that we could not randomly select four sites that would provide generalizable information. We purposefully selected diverse sites that would provide a range of factors involved in the implementation of Buddy. Areas for diversity included; hardware platform, length of involvement in the project, school size, demographics, and socioeconomic status. The four sites selected were:

• Taft Elementary School[1] -- A rural school with an IBM lab, Taft was one of the original five pilot schools. The school provided a population with a broad range of SES and no racial diversity (100% white). The program included two fourth-grade and two fifth-grade classes.

• Maplewood Elementary School -- A suburban school with an IBM lab, Maplewood was one of the original five pilot schools. The school is a Discovery Magnet Program school with an emphasis on science. The school provided a population with a range of SES and some racial diversity. The program included four fourth-grade and four fifth-grade classes. Maplewood was slated to be one of the first Buddy schools to make the transition to parent buy-in of the home computers.

• Plainview Elementary School -- An urban school with Macintosh computers in each classroom, Plainview was in its second year of Buddy involvement. The program at this school included two mildly mentally handicapped (MiMH) classes, one fourth-grade and one fifth-grade class. The sixth grade was added in 1992-93. The school offered a population with a low to medium range of SES and some racial diversity. This site was also identified by the Buddy office as one of the most innovative schools in its use of computers.

• Linden School -- An urban school with Macintosh computers in each classroom, Linden was in its first year of Buddy involvement. The program included two fourth-grade classes and one LD class. It will expand in successive years to include fifth and sixth grade. The school's population offered racial diversity and consisted of students from predominantly low SES families.

Family Selection. At each site six to eight families were selected for home visits. We selected a range of student characteristics that included academic achievement levels, level and amount of computer use, socioeconomic status, race, and gender.

Calendar of Case Work

Two researchers were assigned to each of the sites. The teams logged between 18 and 21 days at each site. Visits to homes and school, some in tandem, some individual, were spread over three time periods during the 1991-1992 school

[1]**Anonymity** The name of the site and of all staff, students and families have been changed to protect their privacy. In some cases, non-consequential identifying features were also changed to further protect anonymity.

year: two to three days in late November and early December of 1991; four days in January or February of 1992; and three to four days in March or April of 1992.

Methods

- Open-ended interviews with participants.
- Observations of schools, homes and electronic network.
- Review of program-, school- and student-generated documents.

Interviews. The interviewing methods were designed to allow for free-flowing discussion guided by the established foci about computers use, teaching styles, classroom interactions and instruction, and problems encountered. The relationship between home and school was also discussed. Probing questions clarified participants' definitions of terms and provided better understanding of the meaning of responses. Interviews were tape-recorded and then transcribed for analysis.

The student interviews were conducted on a one-to-one basis during the school day and were approximately twenty minutes in length. The purpose of the interviews was to determine the students' perceptions of their own and family use of the computer and network, what was liked best and least about the project, and how school assignments had changed since the introduction of the project.

The teachers' interviews were conducted during free periods and lunch times. These interviews were more extensive than the student interviews and often had to be spread over several days because of their length and the lack of a continuous block of time. There was also an on-going casual dialogue with the teachers throughout our visits. Interview questions sought to explore teachers' perceptions of changes in classroom management styles, their relationships with students, parents, and other teachers as well as the typical and optimum uses of computer and telecommunications functions.

Principals and the site coordinators were initially interviewed for approximately an hour. There were follow-up interviews with some of the site coordinators. Questions focused on perceptions of organizational and pedagogical impact of the computers and the telecommunications functions.

The interviews with families took place in the homes and typically took an hour and a half on the first visit and approximately half an hour on the second visit. The family members were interviewed as a group. In each case, the Buddy student had previously been interviewed individually at school. In these interviews, we attempted to determine the family's use patterns and perceptions of the strengths and weaknesses of the project.

Observations. To gain a better understanding of teaching styles and approaches, we observed teachers instructing both with and without the computers. During the observations of computer activities, we asked the teachers pre- and post-observation questions to determine their perception of the lessons' objectives, why they had selected the computer for the particular task, and how successful they felt the lesson had been.

BuddyNet was observed to determine the content and continuity of the teachers' homework postings. Between January and May of 1992, the announcements on the electronic bulletin boards of the schools were down-loaded

on the average of twice a month. In addition, conversations from the main chat channel were observed for ten-minute intervals at random times of day on the average of once a week. Samples of these exchanges were also down-loaded t· provide a comparison to what participants reported of network use.

Content Review of Documents. Documents were collected from each site. The collection included the site's implementation plan, a site description and student-generated work. Articles written by newspapers and journals about the schools and about the Buddy System Project, as well as Buddy-generated publications were also collected. These provided background information about the schools and program and offered further means of understanding what was being accomplished with the computer.

Credibility and Analysis. To increase the validity of conclusions, the technique of "triangulation" (Denzin, 1978) was employed. Triangulation requires data be substantiated from at least three different perspectives before it is submitted for conclusion. There are four different ways to triangulate data: use of multiple and different sources, methods, investigators, and theories. This study utilized three of the four ways. Two investigators were assigned to each site, multiple data sources were used, and data were collected through a number of methods including observations, interviews and document reviews.

To construct the cases, the collected data were organized as a function of preparing to write. Triangulation and participant review were used to correct errors of fact and to gain general confirmation of what was written. Review comments did not guarantee revision, but consideration was given to how the suggestions could help provide more complete, accurate and balanced reports.

The School Learning Environment

Computers often receive lukewarm receptions from teachers. They are unsure of how to use the computer, in both a practical sense as well as a pedagogical sense. The extensive availability of computers and the training that Buddy provided were identified by teachers as two factors that produced a noticeable increase in the level of computer use in their classrooms. Though comfortable with the technology, few teachers in our study articulated a "special" philosophy of computers in education. The majority saw computers as another tool in their pre-existing toolbox. There were no cases of changed curriculum due to the addition of computers. Some teachers noted that they were able to go into more depth on the subjects, but felt that they did not cover any additional material outside of computer literacy. While the technology did not revolutionize their approach, it did cause the teachers to think about their teaching approach.

Computer Configuration

There were three significantly different configurations of the computers throughout the four schools. At Plainview, the students sat at tables arranged in a U and the computers were spaced evenly around the tables. Thus, the computers were always available for use. Furthermore, by their placement among the students, the computers were positioned to be used in cooperative work groups.

At Linden, the computers were lined up along the wall of the classrooms. They were positioned so that only one student (two in a tight squeeze) could sit at the computer. Thus, while the computers were in the classroom and available, the

class had to be disrupted to go to the computers. The limited space meant they had to use a rotation system. This individualized approach reduced the time the students could work on the computer and limited the types of projects in which they engaged.

The other two schools placed their computers in a separate computer laboratory. This severely limited access to computers, although it did permit each student to work at his or her own computer.

Amount of Use

The school's choice of a separate computer lab, or in-class mini-labs was related to the amount of integrated use. Teachers with mini-lab configurations were more likely to use the computers throughout the day. Use of the computers at the lab schools was restricted to the time assigned in the computer laboratory and as a result, use was far less frequent. Those with labs viewed computer time as separate from class time and were more likely to emphasize individual work on the computer. Indeed, we found the use of the computers to be separate from the remainder of the academic activity in that the use of the computers was not discussed until the students were lining up to go the lab. While a configuration might reveal a pre-existing philosophy, it also perpetuated particular uses. Teachers were confined to certain approaches given the physical constraints of computer access.

Extending schoolwork. The teachers emphasized the need for both school computers and home computers to facilitate the most successful use of the computer. Without the home computers the students would not have had sufficient time or access to complete projects or to practice drill assignments. As one teacher noted:

> So much more can get done at home where the kids are more relaxed. That's the best thing about having them at home for me, and for them too. They can practices what they need without being interrupted or judged.

On the other hand, students were unable to progress as quickly on their home computer when they were not introduced to concepts and software at school. According to the teachers, the combination of access was especially crucial to the students' progress in touch typing and editing functions. These were viewed as important because typing facility affected the students' composition writing.

Level of Proficiency

The students at all four schools possessed a basic proficiency with the computer. By all observations and interviews, these students could easily turn the computer on, load software, and open and use the basic operations of the available software. Students at Linden, a first year Buddy school, were the least proficient. They were still, however, able to open programs, use the word processor and graphics programs, and (for the most part) create basic HyperCard stacks.

Type of Use

The nature of the use of the computers is central to understanding their effectiveness. The goal of the Buddy System Project is for computers to be viewed as tools to aid learning in the content areas. Ideally, tool use will permit the students and teachers to engage in activities that would not be possible without the

computers and that will give the students new and richer insights into the content areas. The schools varied in the degree to which this was accomplished.

We identify four general ways in which computers may be used in the school learning environment, including tool use, to practice content or skills, for computer literacy, and as a reward for good behavior. We use these classifications to guide our discussion of the uses in the schools, beginning with the tool use that best reflects the Buddy philosophy.

As a tool to develop and present information. It is this use of computers that is central to the Buddy philosophy. The computers are integrated into the instruction and serve as a tool for working in the instructional domain.

The teachers at all four schools promoted the tool use of the computers. The teachers emphasized that the computer not be viewed as being for games but rather for work. Most often, the "work" involved a substantial project: a History Day presentation; a submission to an essay competition; a proposal for a space station. The teachers noted that it was only because of the ready availability of the computers both at home and at school that they could do these larger tasks.

This philosophy was perhaps most fully realized at Plainview. Except for the typing program, the use of the computer was predominantly used for tool based software: HyperCard, graphics programs, and Microsoft Works which contains word processing, data base and spreadsheet applications. HyperCard was used extensively to create presentations in science and social studies. However, this was not just a substitute for paper and pencil work. Rather, these teachers saw the presentations as forcing the students to give greater consideration to the audience and to the use of original rather than secondary sources. The computer permitted them to prepare richer presentations by incorporating original sources such as video or audio clips. For example, one student writing about the first African-American teacher in Plainview sent an audio tape and some questions to that teacher who now resides in California. The teacher provided the answers on tape and those answers were digitized and included in the HyperCard stack. The science teacher at Plainview talked about his plans to use public databases that would permit the students to engage in real scientific activities. In these examples and in most other instances of using these software programs, the students were in charge of deciding the topic and designing the product. The teacher served as an advisor to help the student reach his or her goals.

The teachers at Linden were also actively searching for ways to integrate the use of the computer into the curriculum as a tool for learning. They spoke of empowering students. Implementing this instructional philosophy proved difficult. As a step towards a richer learning environment, the teachers required the students to develop HyperCard stacks on science as a substitute for their science tests. While we see this as a positive direction, the teachers did not fully realize their goal of a "richer" learning environment. Rather than giving the students freedom in design, and serving as advisors, the teachers maintained considerable control over the design and content of the stack. The number of cards and the content of each was pre-specified. In another project, the HyperCard stack had to be produced on paper and submitted to the teacher for approval before being typed into the computer. As a consequence, the assignments degenerated into worksheet type exercises. It was more fun for the students and it engaged them longer, but it was a worksheet nonetheless. As the site coordinator at this school noted, there is a need to help "teachers change attitudes about how information is learned and how to

impart information." They need to move away from the old paradigm of information transmission by an expert teacher.

At Taft and Maplewood the teachers talked about the computer permitting them to work on large projects; projects that would not be possible without a computer. As one teacher noted:

> Most of the time what we do on the computer has many steps to it. There's a purpose for every one of them, there's a sequence to it, and there's a goal at the end. You wouldn't be able to do that if you didn't have a computer. It would be too time consuming, too frustrating.

As an example of this type of activity, she noted that they were preparing a proposal for the creation of a space station using the word processor and graphic program. The proposal, when completed, would be about forty typed pages.

Provide practice in a content or skill domain. Here we are referencing the use of educational games as well as drill and practice programs. This includes drilling the student in typing, math, spelling, and grammar. It also includes educational games such as "Where in the World is Carmen San Diego?" where students practice problem-solving skills and information-seeking skills.

At Taft and Maplewood, the students regularly worked with spelling, arithmetic, grammar, and typing programs. Based on our observations, it would seem that 40% of the computer time was spent on these activities. At Linden, drill and practice software was used less frequently, but the tool applications were often utilized in a drill and practice manner. For example, the word processor was used to type in the weekly list of vocabulary words and then erase them as a means of practicing typing and vocabulary words at the same time. In contrast, Plainview used little drill and practice programs in the regular classrooms except for the use of a touch typing program and a math "game."

Drill and practice are frequently used with the special education students at both Plainview and Linden. The repetitive nature and the immediate feedback offered by these programs is viewed as especially appropriate for the limited attention span of these students.

Computer literacy. A focus on computer literacy is geared to having the students learn about computers. This entails teaching what a computer can be made to do separate from other instruction instead of using the computer as a tool for working within a content domain. In general, we found a tendency to focus on computer literacy as a goal when the teachers were struggling to integrate the use of the computers into instruction. For example, when having students create databases using a spreadsheet or database program, there was typically little concern with the content, the goal was to give the students experience with the mechanics of the software We think that instruction would be more meaningful to the students and more efficient instructively if the use of the database involved helping the students ask more meaningful questions within the content areas they were studying.

All four schools needed to provide a computer literacy orientation to their incoming fourth graders. For the most part, the entire fourth-grade year is a time when the students learn to use the tools, and by fifth grade the students are able to

use them more as tools for work. Several of the schools offer summer programs before the fourth-grade year to teach basic computer literacy.

In the schools that have been implementing Buddy for several year now, it is becoming clear that the basic computer literacy is disseminating to students even before they reach the fourth grade. As many as half of the incoming fourth-grade students at these schools are literate because of their exposure to neighbors' and siblings' Buddy computers.

To reinforce good behavior. When classroom access to computers is severely limited, teachers frequently offer use of them as a reward for good behavior. This approach undermines the potential of the computer as a tool for learning. We were pleased to see little use of the computer in this way among our schools. One exception was in a Linden class where if students did computer homework they were excused from ten minutes of math class so that they could do whatever they wanted on the computer. Students who completed computer homework for the week were given a shareware (computer game) program to take home. Two students in the class whose behavior was unsatisfactory were threatened or faced with the removal of their home computer. While this approach encouraged home use of the computer and had a seemingly positive effect on the behavior of the two students, it presents a dangerous precedent. It creates an attitude that emphasizes computing as a reward, and as something to replace learning other subjects. This approach is contradictory to the integrative tool-use attitude toward computers that Buddy is trying to encourage.

Self-Esteem

An overwhelming response from the teachers at all four sites was that the computers improved the self-esteem of the students. There were two ways in which this happened. First, the products they produced looked better and as a result the students felt greater pride in what they did. Second, the students became experts in the use of the computer. For the most part, they had knowledge that exceeded that of the teachers and family members. Further, they were often called upon to teach adults and other students. This increased self-esteem translated into greater enthusiasm for school.

Equalizing Students

The computers played a particularly important role for those students with learning disabilities and for students who tend to be outliers in the class. As one student at Plainview told us, "Some of the kids that aren't that good in school are good on the computer. It's kind of an extra talent that they have." This is especially true in an environment like Plainview where students are encouraged to discover new functionality and new applications of the programs. Everyone could readily contribute.

On a broader basis, and with much greater implications, the computers seem to provide particular support to students with learning disabilities. Students with attention deficits are able to work for longer periods on the computer. Students with limited manual dexterity can now produce papers that look as neat as everyone else's. The program has influence how others view these students and how they view themselves. One teacher noted that their abilities on the computer had "reprogrammed" her expectations of what they were capable of doing. Another teacher noted that the development of computer skills by students in the special

needs classes will permit them to be mainstreamed and even excel in the computer classes in middle school.

The impact of the computer technology on the special needs students was one of the greatest success stories that we observed. There were three such classes in our cases: two classrooms at Plainview with students classified as "mildly mentally handicapped" and one classroom at Linden where students were classified as "learning disabled." In all three of these classes the teachers, students, and parents extolled the impact on the students. They were learning more, they were remembering more, and they were getting more practice at life skills like communication (using telecommunications) and problem solving (learning how to use the programs).

Cooperative Learning

The Buddy System Project promotes cooperative learning. In some schools where this was already the instructional model, the computers seemed to enhance cooperation and sharing. Even where this model was not operative, there was a noticeable increase in sharing among students. Teachers at all four schools told us (and we observed) that the students naturally wanted to share and help each other in using the computers. As a teacher at Linden told us, her class had been quite protective of their work and unwilling to share; however, with the computers, they seek to work together and share expertise.

Energizing the Teachers

While the teachers emphasized the enormous amount of extra work required in implementing the Buddy program, almost all also noted that the program energized them and caused them to rethink their curriculum and their approach to teaching. Almost all of the teachers saw new opportunities in learning and saw the students in a new light and this seemed to have an energizing effect. This is expressed most succinctly by a teacher of mildly mentally handicapped students. She reported that during the first year of the program she worked an extra 20 to 40 hours per week on the Buddy program. Yet she reflects on her experience in the most positive of terms:

> Perhaps we in education have unknowingly limited [our] students by prejudging what they can and cannot do. . . With the Buddy system I did not know enough to limit them with my expectations since I truly did not know what to expect. . . In actuality this became a very happy and fun classroom, unlike anything any of us had experienced. . . I don't know who gained more in these experiences, students or teacher.

Culture of the Classroom

Clearly a change of the magnitude of the Buddy System Project may be expected to impact the culture of the classroom by affecting the way the class interacts and the way everyone thinks of learning and teaching. We saw some of these changes in all the schools. In particular, all of the teachers recognized the expertise of the students and began to rely on this expertise in solving problems. Buddy helped shift teachers away from the model of the authoritarian. While we still saw authoritarian teachers, it is clear that the stance was reduced through Buddy and a more cooperative learning environment involving students and teachers as partners was promoted.

All of the teachers and most of the students and parents we talked to, were aware of the change in relationship. Rather than resisting the loss of power and expertise, the teachers seemed to bask in the glory of the developing expertise of their students. It was exciting of them to see the students being able to teach them. It allowed them to see the students in a new light, recognizing capabilities far beyond what they had previously believed possible. In a similar vein, the students experienced the role of "teacher" with all of its problems and work and witnessed first hand that learning is a lifetime experience.

Willingness to work. All of the teachers and students reported that working on the computer was more fun. It was generally agreed that the students were more willing to do school work and homework on the computer and were more enthusiastic about doing it. This may well have been a temporary effect due to the computers being new; however, we did not see the effect significantly subsiding across grade levels or in schools with four years of involvement.

Improved writing and composition. All teachers reported that using the word processor improved writing skills. This was seen in the amount written and in the details provided in the writing. Several teachers noted that students are no longer asking how long the essay had to be, but rather are asking how long they could make it. Interestingly, it did not mean that spelling was better even though a spell checker was available. The children, almost universally, told us that they liked writing on the computer because it did not hurt their fingers like writing did. It was easier for them to write more, so they did. The professional appearance of the printed papers has raised self-esteem, especially for low ability students. The increased legibility also helped students proof read their own papers more effectively.

Problems

We identified two significant problems in the use of the computer in the classroom. The first was initial student training. The fourth-grade teachers have spent too much time teaching computer mechanics at the beginning of the year. While this has been a problem, all of the schools have already generated their own solutions. Maplewood has designated the whole fourth-grade year as the time to develop computer literacy. The other schools have initiated a Buddy summer school in which the new fourth-grade students received training in the primary applications. The second problem has been maintenance of hardware and of local area networks where most of the software was stored.

Telecommunications

When the students were asked what the Buddy Project meant to them, they overwhelmingly responded "BuddyNet." This electronic network was used to post homework assignments and Brain Teasers, to conduct a summer Buddy Program (at Taft), and to communicate with people from all over the state.

Empowerment

One of the most exciting telecommunications observations is its potential to empower diverse groups (low ability, rural, minorities). The anonymity of the communication minimizes such diverse and often segregating conditions as gender, race, physical appearances and socioeconomic status. In one rural area that has a reputation for racism, the program coordinator reported that this electronic

connection has provided the students with positive and otherwise unlikely exposure to racial diversity.

At another school, the students come from a background that gives them limited expectations of their future. This is reinforced by both economic and cultural factors. BuddyNet provides an opportunity for interaction beyond the boundaries of their immediate environment. It allows them to communicate with students from other schools and provides the potential for exposure to new perspectives and higher expectations. Already, teachers have noticed a difference in the students' spelling and grammar as they strive to communicate in this new environment.

Social Outlet

BuddyNet also creates an environment where socially awkward students can find their own niche. While many early computer studies raised concerns over the desocialization caused by excessive computer use, BuddyNet had quite the opposite effect. Shy, quiet students often preferred this vehicle to communicate with teachers and with others of their own age. The network hides physical imperfections and personality flaws which frequently serve to isolate students in the classroom..

Several teachers reported cases where e-mail opened channels with students with whom it was difficult to communicate. They noted that painfully quiet students who they were unable to convince to speak in class often initiated communication through extensive e-mail messages. New students or those who having problems were subtly and easily "touched" in short e-mail messages.

The Mall Syndrome

The chat and e-mail capacities also provide a place for the students to "hang out" socialiy. In this way it is strikingly similar to the teenage "mall syndrome." Students would pre-arrange to meet each other, or would telephone to see if a friend could get on BuddyNet. The extended network connected students to people in different areas of the state and, for those with *Prodigy* capacity, the country.

Time On-line

Students often preferred spending time on BuddyNet chat or *Prodigy* to watching television. Our data showed little parental concern with the amount of time spent in front of the computer or in front of *Prodigy* which shows more advertising than Whittle's *Channel One*. The interactive nature of the computer made it more appealing to the parents and the communication aspect made it more appealing to the students. There were some complaints of extensive tie ups of phone lines, but families seemed to have worked out time schedules, or were resigned to the belief that the benefits to the child of being on-line outweighed the inconvenience.

Rules and Regulations

Taft, more so than any other school staff, "chaperoned" the students' social use of BuddyNet. There was a nightly curfew and fourth graders were restricted to the school chat channels; general chat was something they graduated to in the fifth grade. Adults were often on-line to remind students to place a period at the end of a sentence or to serve as a presence that encouraged a higher standard of interaction. Linden, in comparison, had few rules and no curfew.

Facilitating Home-School Communication

The e-mail function had a variety of levels of uses for facilitating communication between home and school. The most common "use" was the perception that the lines between home and school were more accessible. Because homework assignments are often listed on the school bulletin boards, it is difficult for students to tell their parents that they have no homework, and teachers, parents and students credit this factor for the increase in assignment completion.

Personal Invitation

Teachers found that when the students read their assignments over the computer, they were more likely to be motivated to complete them. One teacher theorized that perhaps his requests seemed more personalized when they were seen on the students' home monitor.

> I think standing in front of the class, they can see that you're talking to everyone. I'm not sure when they read it on their computer that they realize that you wrote that same message to everyone. I think if you asked them about it they'd understand that, but somehow because it is one letter to them in their house it is personalized; and then, they had to write back to me personally.

Real-Life Applications

BuddyNet provided real-life opportunities to communicate in the written form. Teachers emphasized that this writing practice was more likely to occur in the e-mail mode than in the chat channel. In e-mail and on the bulletin boards the students were more likely to write full sentences and paragraphs. For example, one principal received an unprompted e-mail note from a student protesting the school ban on remote control cars. What pleased the principal most about the letter was the student's initiative and the real-life purpose behind the communication.

Tutoring On-line

The electronic functions opened some unexpected gateways to learning. One student with a severe reading learning disability was "adopted" by a woman in another community. The two met on-line every night and through "chatting" improved the girl's reading and writing skills. Adults noted that the written format of the highly popular chat and e-mail has a positive influence on the students' reading and writing proficiency.

Summer School

Taft, the rural school, conducts its summer Buddy program on-line. Prior to the introduction of the Buddy System Project, none of the teachers at Taft taught summer school classes. The school building was closed for the summer. Any Taft student who wanted to participate in summer programs (for either enrichment or remedial reasons) had to be driven into the nearest town, which is almost twenty minutes away. In contrast, the on-line learning environment created in BuddyNet is easily accessed and can be attended to at a time that is convenient to each individual student and teacher. The on-line projects allow and encourage all levels and abilities of students to stay involved with learning over the summer months. They reinforce what had been learned the previous year, explore new topics and provide a way for

teachers to become more familiar with the students and their needs before the class physically convened.

Problems

Forgotten or mis-entered passwords were a frequent source of confusion for new users. Mis-loaded software also prevented many new users from logging-on for several weeks, by which time they had forgotten the procedure. Using the telecommunications feature rendered the family line busy. If the family had call waiting, an in-coming call would bump the user off of the network. Both of these situations were considered nuisances by the participants.

Family Involvement

This section concentrates on the information culled from home visits. Research of home use of personal computers is, to date, lacking. One goal of the Buddy System Project is to support the entire family in developing computer skills and in integrating the computer into their daily lives. Home visits and family interviews provided insight not only into family computer use, but also into the home computer's role in the child's education.

Use of the Computer

Use by Parents. The two most popular activities among the parents were the use of *BuddyNet* and *Prodigy*. The chat channel was by far the most popular use of BuddyNet. Parents and children alike spent long hours simply talking with other people on the system. Most often this was general social chatter. However, the effect was not always neutral. For example, through the Buddy chat channel, one parent learned of another parent's problems with a water heater on Thanksgiving Day and was able to give advice over BuddyNet on how to make the repair. At the other end of the spectrum, there have been numerous instances of foul language and flirting by the parents on BuddyNet.

There were some instances of the use of the Buddy computer to help with work-related tasks, but this was infrequent. Most often the computer was used as a word processor to generate letters, newsletters, or announcements. One mother used the system to keep records from her job as a nurse. However, the removal of the computer for the summer inhibited her from continuing that activity when the computer was returned that following school year. Several parents noted that they used the BuddyNet to contact and communicate with the parents and members of their scout troops. Another parent told us of a school committee meeting that was held on-line because it was more convenient and time efficient than driving to a common meeting place.

Often we heard about parents' plans to use the computer -- plans that never seemed to be realized. For example one parent who is in sales indicated he intended to use the computer to maintain a client database. However, when we returned three months later, he told us that he had not done anything yet because he had long hours, as well as a lot of travel with the job. Another parent indicated that she would like to use the computer for family budgeting, while a third indicated that he saw it as a mechanism for managing his stamp collection. Finally, one parent saw the computer at home as making it easier to take a computer class that would help her develop the computing skills necessary for secretarial work. However, she was

still too unfamiliar with the computer and it's uses to be able to express just what skills she needed.

Use by siblings. The use by the brothers and sisters of the Buddy child is dominated by games and BuddyNet. The children do not seem to distinguish between educational and non-educational games. That classification seems to be one that we as adults impose. Graphic programs are also popular with younger siblings, but generally not with older siblings. It is interesting to note that the siblings in the families we interviewed did not use the computer for their homework. This was true even with siblings who were "Buddy alumni." This reinforces the notion that the effective use of the computers requires the creation of a culture for its use.

Buddy home computers have contributed to general dissemination of computer knowledge. Students entering the fourth grade are increasingly familiar with the buddy computers and software; even those who have not had a computer in their home yet. At one school in its fifth year of implementation, approximately half of the members of the incoming fourth-grade class were familiar because of their exposure to neighbors' and siblings' Buddy computers. Parents noted that the home computers had made them more comfortable with and aware of hardware, software, and the potential held by the development of computer related skills, such as word processing.

Homework

Parent involvement in homework. In many cases there was no change in the parents' level of involvement with homework. However, across the schools we did see three types of effects. First, the newness of the technology and the child's expertise attracted the parents to the activity. They would share the homework time with the student, learning the technology as the student did. Second, the activities of the school required the parents to be more involved. This was the case at Plainview. Parent involvement remained high as long as there was a requirement. Finally, some parents were frustrated in their attempts to work with the child because they did not know how to use the software and hence could not provide help.

Dealing with divorce. The effective use of the computer for homework is a complex issue because of the structure of family units in our modern society. Specifically, a large proportion of the students in three of the schools come from families where the parents are separated or divorced but with both parents still living in the same general area. As a consequence, the children actually reside in two homes; the mother's and the father's. Their access to the home computer depends on whose home they are in for the evening. The teachers have used three strategies to manage this problem. First, use of the computer for homework is made optional. Students may do it on the computer or not, as they see fit. Second, the computer homework is a means of achieving extra credit. If the homework is done, then bonus points or some other reward is given. Third, the student is given time to work on the computer homework assignment at school.

Parent-School Linkages

We found that while parents agreed that the program improved parent/school relations, they did not perceive as great an improvement as the school staff had. Both recognized that the logistics of getting the equipment home required an increase in the number of contacts between teachers and parents. Because these

contacts were for an action considered to be neutral or positive (instead of a negative confrontation over the child's grades or behavior) teachers and parents noted that they felt communication had improved. Perhaps the electronic communication's greatest "usefulness" was not an increase in actual communication, but rather an increase in the *perception* that the lines of communication between home and school were more accessible.

Buddy also facilitated the opportunity for school staff to visit homes. Setting up the home Buddy computer sometimes created a need for a visit from a school staff member. Taking the initiative to meet the family on their "own turf" under positive circumstances was well received by the families. Through seeing the home situations of students, the teachers were able to gain a better understanding of behavior observed in school.

The BuddyNet e-mail and bulletin board functions are also used to facilitate communication between home and school, as well as to get parents more involved in their child's education. Teachers who actively established improved communication with parents as a high priority used successful tactics such as requiring parental e-mail each night upon student completion of homework. Other teachers post assignments that require the involvement of family members. The posting of "brain teasers" at one school has become a well received family activity. The program's emphasis on family involvement has received mixed reviews from parents. Some felt that these assignment checks were an imposition, others, often those who were already involved, were pleased with how easily they could now stay in touch with their child's work. One mother noted how excited she was because her husband's interest in the computer had enticed him to get involved in their son's schoolwork for the first time.

Empowerment at Home

The position of the student within the family structure was considered by many to be enhanced. For one mentally handicapped girl, her knowledge of the computer offered her the chance to be a "contributing member of the family for the first time." Another mother was surprised at a mutually interesting conversation with her son about her work with databases. Parents interviewed said that their opinions of what the children were capable of achieving had increased dramatically since involvement in the program.

Problems

There were varied reports of family tensions and anxieties caused by the introduction of the computer into the house. The extensive tie up of telephone lines for electronic communications use was the most highly reported problem. Adult use of "chat channel" for reasons ranging from extensive time on-line with friends to flirting was also recognized as a source of tension.

Conclusion

Buddy was successful in all of the schools. The computers were enthusiastically received and were being used extensively. There was a high use of tool-based software that permitted the students to generate and process information, and a minimum use of the computer for rewarding behavior or for rote instruction. Further there has been a renewal effect on the teachers and a positive impact on the

culture of the classroom. In this section we examine what we feel are factors that underlie the most successful implementation of the program.

Length of Time in the Project

It was clear from observations and interviews that the first year a school is involved requires an enormous amount of work. The logistics of getting the computer into the homes takes an incredible amount of planning and energy, and no amount of helpful hints takes the place of actually going through the process. In addition to logistical concerns, teachers and students are learning how to use the software and what they can do with it.

High Computer Access

We heard over and over again that the computer activities were only possible because there were computers at school and at home. If the teachers are to engage in larger, student-centered projects, it simply can't all be done at school. The home computers permit the teachers to expect the school projects to continue at home and thus permit them to assign larger projects.

A Student-Centered Instructional Model

The computers are a vehicle for the students to create and manipulate information. This use of the computers is most successful in a student-centered approach to learning, when they are used to contribute to project-based learning. In contrast, the teachers at Linden tended to provide very detailed instruction to the students as to what they will create, with very few degrees of freedom left to the students. One of those teachers expressed a wish that all the students could have their own computer so everyone could be doing the same thing at the same time all under her direction. We have doubts as to whether this teacher can be success with that philosophy.

A Purpose for Using the Computers

If the computer is to be a tool for learning, then it is essential that the plans for using the computers begin with learning goals. That is, instructional goals and not computer goals must drive the activity. However, the computers offer new opportunities for thinking about and working in the content areas. It is not adequate to simply reflect on traditional learning goals; rather it is necessary to consider what new opportunities for learning and understanding are available. There is not such thing as "just another tool." Each tool for learning offers particular opportunities for learning and understanding and we must understand the strengths and potentials so that it is a tool that is used effectively.

Teachers Attuned to Adoption of Innovations

It seems to us that a significant factor in successful implementation is the presence of several innovators; teachers or administrators ready to take chances, work at the cutting edge, and lead the way for the others at the school. In addition the success of the program would not have been possible without a large amount of extra effort on the part of the teachers. All the teachers reported spending long hours learning about software and trying to "keep up with the students." In all cases the teachers reported that the effort was well worth it. They saw the value of the computers, embraced the opportunity, and were willing to spend long hours.

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