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ABSTRACT

This final report describes findings of a 3-year study on the effects of an Interactive Technology Literacy Curriculum (ITLC) on emergent literacy knowledge and abilities of children (ages 3 to 5) with mild to moderate disabilities. Using a case study approach, 16 preschool classes in four types of classrooms in West Central Illinois communities were studied using qualitative and quantitative data from the children, their families, and the staff. Classrooms were typed according to the teacher's technology experience: Type 1 had teachers just beginning to use technology; Type 2 had classroom teachers experienced in using technology and who used the ITLC during the first year; Type 3 teachers had technology available, carried out typical preschool activities, and served as a comparison group; and Type 4 comparison classes had classroom teachers who did not use technology. The ITLC was based on an emergent literacy approach and used software that included interactive literature-based commercial software, a software authoring system, software produced by other classes using the authoring system, and tool function software such as graphics and story-making. Results indicated that across experimental ITLC sites, children made significant gains not only in emergent literacy behaviors, including communication, but also in positive interactions. Appended are the research instruments and the coding system used. (Contains 47 references.) (DB)

Final Report: The Early Childhood Emergent Literacy Technology Research Study

by
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Final Report: The Early Childhood Emergent Literacy Technology (EC-ELT) Research Study

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II. Abstract

The major purpose of the 3 year EC-ELT study, conducted by Macomb Projects in the College of Education and Human Services at Western Illinois University, was to describe and explain the effects of an Interactive Technology Literacy Curriculum (ITLC)[1] on emergent literacy knowledge and abilities of 3, 4, and 5-year-old children who demonstrated mild to moderate disabilities. Because ecological systems must be considered, the effects of the curriculum on preschool staff, setting, and families were also of interest. Based on rigorous naturalistic inquiry, the study incorporated a case study approach, studying 16 preschool classes in West Central Illinois communities. Four different types of classrooms, the unit of measurement, were studied, in depth, and categorized on their technology[2] use for comparison purposes. The impact of the ITLC was determined using qualitative and quantitative data from the children, their families, the staff, and the settings of the participating classrooms. The ITLC demonstrated positive effects on emergent literacy knowledge and skills of the children in the classrooms studied.

The study was designed in three phases. Phase 1 occurred in the first year, Phase 2 during the second, and Phase 3 during the third. Preschool sites in rural and small urban Illinois public school settings participated in the study. The classrooms were classified according to the teacher's technology experience. Type I classroom teachers were beginning to use technology. Type II classroom teachers were experienced in using technology. These classrooms received the Interactive Technology Literacy Curriculum during Phase 1. Type III classroom teachers had technology available, carried out typical preschool activities, and served as a comparison group. During Phase 2 and 3 Type IV comparison classroom teachers who did not use technology were added. The Types I and II classrooms were subdivided further for purposes of data analysis.

Phase 1 provided a description of the effects of implementing the Interactive Technology Literacy Curriculum in the initial three preschool classroom types. Phase 2 tested the findings of Phase 1 and gathered data on Phase 1 sites over time. During Phase 3, longitudinal data was continued in Phase 1 sites, as well as the Phase 2 sites. During each Phase, new sites were added as classrooms changed classifications.

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[1]The ITLC was later incorporated into a curriculum, *eMERGing Literacy and Technology, Working Together*, developed in collaboration with a model emergent literacy project.

[2]"Technology" is defined as the use of computers, printers, TouchWindows, other peripherals, tape recorders, and video cameras.

Data collection included pre- and post-tests, observation, interviews, examination of records and materials, analysis of videotapes, content analysis, and other methods. Records of individual child behaviors, dyads and small groups during curricular activities, and videotapes of ITLC use were maintained.

The Interactive Technology Literacy Curriculum, based on an emergent literacy approach and Macomb Projects' successful experience with young children and technology, included software selected via an analysis of the quality and interactivity levels of the software, appropriateness, and appeal to children. The curriculum is organized in four sections which were presented differentially to Classrooms I and II during Phase 1 and again in the next two phases. The sections are (1) interactive literature-based commercial software, (2) software classrooms produce themselves with *HyperStudio*, a software authoring system, (3) software other classrooms produce using *HyperStudio*, and (4) tool function software such as graphics and story-making. Each section of the curriculum contained on-computer and off-computer activities which contain important elements of emerging literacy.

Results indicated that across experimental ITLC[3] sites, children made significant gains not only in emergent literacy behaviors, including communication, but also in positive social interactions. We had not expected that two classroom management tools would generate such powerful positive effects on child behaviors—the use of *KidDesk* and the use of sign-up sheets or books. The effects of interactive commercial software, tool function software including graphics programs, and class-produced *HyperStudio* stacks produced positive behaviors in literacy, communication, and social interaction. However, children's use of *HyperStudio* stacks made by those in other classrooms was not successful and produced little interest. Significant effects emanated from the research staff conducting ITLC activities, as compared to classroom teachers (no matter what their previous experience with technology), a finding that led us to analyze our data using the presence or absence of the research staff's activities as a variable. Families and teachers in all ITLC classrooms reported changes in children that correspond to behavior observations in the classrooms.

[3]The term *ITLC* denotes the curricular approach used.

III. Table of Contents

IV. Goals and Objectives

Goals

The research goals addressed the problem of illiteracy among young children with disabilities and explored the availability, quality, use and effectiveness of technology as demonstrated through using the Interactive Technology Literacy Curriculum (ITLC). The goals target a description and explanation of the effects of the ITLC on preschool classrooms for young children with mild to moderate disabilities, their families, the staff and relevant aspects of the ecological system. The goals follow.

1. Describe and explain how use of the elements of the ITLC effects the emergent literacy concepts and behaviors of young children with disabilities in preschool classrooms over time.
2. Describe and explain the outcomes, challenges, and implications of the ITLC to preschool staff related to teaching content, skills, and strategies.
3. Describe and explain how the ITLC can be used in preschool classrooms to encourage literacy concepts and behaviors in young children.
4. Describe and explain the characteristics and availability of software and activities which can be used successfully in elements of the ITLC.
5. Analyze and explain the benefits of using the ITLC and the difficulties encountered in using it, together with any negative effects.

Objectives

The objectives to accomplish the goals were divided into two categories: Research Objectives and Management Objectives. Both sets of objectives follow.

Research Objectives

R1. Identify, organize, test, and revise appropriate interactive software and activities into the four elements of the ITLC.

R2. Collect, analyze, and summarize pre-test data on children, families, and staff as well as baseline data on all four classroom types.

R3. Administer the four elements of the ITLC differentially to Classrooms I and II.

R4. Observe, interview, and collect relevant data from children in Classrooms I and II.

R5. Observe, interview, and collect relevant data from staff in Type I and II Classrooms.

R6. Observe, interview, and collect relevant data from children and staff in Types III and IV Classrooms.

R7. Collect post-test data on children, families, and staff in all four classroom types.

R8. Compare and contrast the information and data collected in objectives R1 through R6.

R9. Repeat objectives R3 through R7 in Phases 2 and 3.

Management Objectives

M1. Accomplish start-up activities including administration, hiring, training research associates and participating teachers, Human Subjects review, equipment and software purchase.

M2. Finalize list of participating teachers, other staff, children, and families then secure agreement to participate and signatures on necessary release forms, including release of information about child.

M3. Develop pre- and post- emergent literacy tests, observation format, procedures, interview forms, and other measures needed; pilot them; and collect information related to consistency, validity, reliability. Revise as necessary.

M4. Schedule and arrange for pre- and post-tests, observations, interviews, and other data collection procedures for all four classroom types.

M5. Conduct information gathering activities in all four classroom types.

M6. Analyze information and data collected, including content analysis, triangulation, and audit.

M7. Summarize information, draw conclusions, identify problems, and make recommendations in written form.

M8. Disseminate results of the study to professionals, families, decision makers, and interested citizens on the national level in various formats including journal articles, presentations at conferences, and in other media formats including an interactive satellite television program at the end of the project, if funding permits.

V. Theoretical and Conceptual Framework

Interactive Technology and Emergent Literacy

Computer technology, while not a panacea, provides access to instruction and learning for children with disabilities (Cassatt-James, 1992; Erickson & Koppenhaver, 1995; Hutinger, Johanson, & Stoneburner, 1996). Pairing appropriate literacy activities with current computer hardware and software provides exciting, interesting, and activity-based experiences for children with or without disabilities. The ITLC curriculum is based on the level of interactivity and potency brought to emerging literacy activities by increasingly high quality software and hardware housing greater power and capability. A framework of concepts related to the development of reading and writing influenced the processes used to develop the emergent literacy concepts and outcomes found in the curriculum. Interactive technology forms the basis for the activities that assist children to acquire and develop literacy and language pleasantly, productively, and appropriately. The ITLC builds upon children's home cultures and language and literacy experiences.

Concepts related to emergent literacy form the basis for later reading and writing and are widely accepted in programs for young children without disabilities but are rarely evidenced in special education practice. While emergent literacy has been a research topic in programs for young children without disabilities for twenty years or more, it is only within the past half a dozen

years that it has gained attention in the special education community. A recent search of ERIC documents and journal articles for emergent literacy titles dating from 1990 to the present revealed over 150 entries using 'emergent literacy' and 'early childhood' as key words. However, when the search was conducted for 'emergent literacy' and 'special education,' only nine documents were found. A search of 'emergent literacy' and 'special education' plus 'early childhood' resulted in six documents. A review of textbooks used in early childhood special education reveal few index references to 'emergent literacy,' although 'communication' is included in almost all texts.

Literacy is more than reciting the alphabet. When preschoolers point to pictures in a book or on a computer screen and pretend to "read" the story; when pseudo-letters, then recognizable letters and words, emerge from scribbles in drawings; or when a three-year-old recognizes the Hardee's logo on a hot air balloon and asks for french fries, these children demonstrate behaviors associated with the emergence of literacy. However, initial literacy concepts are seldom addressed in special education programs, a situation that highlights the need to disseminate the findings of emergent literacy research related to youngsters with disabilities to early childhood practitioners.

Research and Emergent Literacy

Literacy is a social, psychological, and linguistic process. Emergent literacy's foundation is based in cognitive psychology and psycholinguistics (Gunn, Simmons, & Kameenui, 1995; Hiebert & Papierz, 1990; Katims, 1994; Mason & Allen, 1986; McGee & Lomax, 1990; Sulzby & Teale, 1991). An emergent literacy approach stresses that written and oral language develop concurrently and interrelatedly from birth. Both oral and written language are best learned when used in purposeful contexts and when children have opportunities to observe and interact with others who write and read (Clay, 1975; Harste, Woodward, & Burke, 1984; Sulzby, 1990) as opposed to rote learning of letters, words, or sounds.

Literacy concepts emerge very early in life. A summary of basic emergent literacy concepts is shown in Figure 1. Since much of what is known about emergent literacy has been based on research with typically developing children (Cousin, Weekley, & Gerard, 1993), even if teachers of youngsters with disabilities know about emergent literacy practices, they may question use of such practices with their children (Patzer & Pettegrew, 1996). Many children with oral language delays and impairments have significant literacy problems before they are in first grade (Scarborough & Dobrich, 1990). Although some suggest that children with mild to moderate disabilities develop literacy in ways that are quite similar to those of children without disabilities (Brazee & Haynes, 1989; Cutler & Stone, 1988; Erickson & Koppenhaver, 1995; Goodman, 1982; Hasselriss, 1982; Katims, 1991; Pierce & Porter, 1996; Reid & Hresko, 1980; Wiederholt & Hale, 1982), typically these children do not have the opportunity to do so and as such, are the children who fall behind in kindergarten and the primary grades. Children who fail to "catch on" early keep falling further and further behind and are likely to end up repeating a grade or are

Figure 1. Summary of Basic Emergent Literacy Concepts

We use pictures and words to communicate.
Pictures have meaning.
Pictures tell stories.
Words have meaning.
Words are used to tell stories.
The words tell about the pictures.
Children can make their own stories using pictures and words.
Stories have a sequence.
Stories have characters, actions, and settings.
Stories have a beginning, a middle, and an end.
We read words on a page from left to right.
We read from the top of the page to the bottom.
There is one to one correspondence between written and spoken words.
Each word we say can be written down, using one ore more letters of the alphabet.
Written words are separated by spaces, just as spoken words are separated by brief pauses.

assigned to transition classes (Strickland, 1990). As children who are "behind" in reading move into the upper grades, they do not "catch up." Rather they stay "behind" (Clay, 1979). The outlook for children with disabilities to experience opportunities to develop literacy is grim.

Many teachers do not view children with severe disabilities as capable of learning to read and write and consequently provide them with few opportunities to learn written language (Light & McNaughton, 1993). Koppenhaver and Yoder (1993) point out that even if teachers view the child as capable, that child is more likely to receive word level skill-and-drill activities, seldom reading or listening to text and more rarely, composing text.

Individual Education Plans (IEPs) tend to emphasize fine motor tasks and self-help skills. Erickson and Koppenhaver (1995) found that when IEPs focused on academics, tasks were likely to include name recognition and rote memorization. Longitudinal case studies (Hutinger, Johanson, & Stoneburner, 1996) of fourteen children who demonstrated moderate to severe disabilities support Erickson and Koppenhaver's findings, revealing that those children, in spite of having sporadic access to technology applications as they progressed through school, rarely learned to read nor did their IEPs focus on literacy behaviors. Models of best practice providing strategies in how to provide appropriate literacy instruction to children with disabilities are scarce at best (Erickson & Koppenhaver, 1995). While the present study collected data on a group of children with mild to moderate disabilities, several children with severe disabilities were housed in study classrooms. Their positive experiences led us to believe that extending the ITLC, with necessary adaptations, should be carefully studied.

VI. Description of the Study, Methods, and Participants

Method: The Interactive Technology Literacy Design

The study was conducted to describe and explain the effects of the ITLC on the emergent literacy knowledge and abilities of 3, 4, and 5-year-old children who demonstrated mild to moderate disabilities. Designed as a rigorous naturalist inquiry, the study incorporated principles from Lincoln and Guba (1985, 1989), Patton (1990) and others (Filstead, 1970; Tesch, 1990). Observations, content analysis of field notes from over 500 hours of observation, videotapes, portfolios of children's drawings and writing samples, teacher and family interviews, as well as pre- and post-test data on an informal emergent literacy and a technology measure were collected on 255 children during a 3 year period.

Preschool classrooms were the unit of measure in the study, which was conducted in 16 preschool classes in 8 west central Illinois communities. Schools were in both rural and small urban communities. Classrooms were classified into four types according to the presence or absence of ITLC and the technology experience of the teachers, ranging from experienced computer users to novice users to non-computer users.

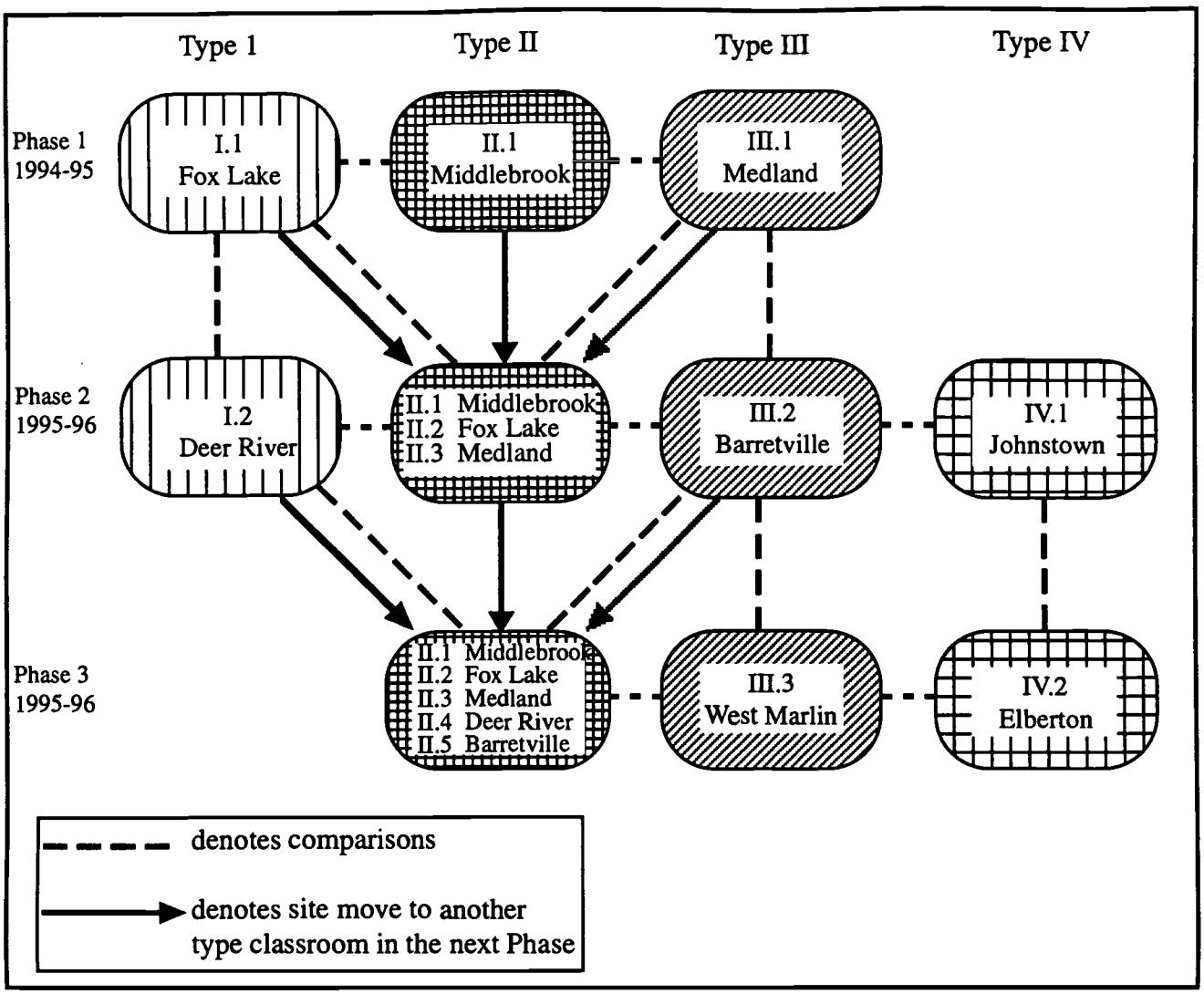
The teachers were committed to the project and participated to the fullest of their ability. They assisted in planning, implementation, and aspects of data collection. The participatory aspect of the study lends credibility to the content and to its practical focus (West & Rhoton, 1992) which was in congruence with 'real world' practice (Dentler, 1984).

Design

Classrooms were originally classified into four types according to the presence or absence of the ITLC and the technology experience of the teachers ranging from those who were beginning to use technology and ITLC (Type I), experienced technology users plus ITLC (Type II), computer use but no ITLC (Type III), and no computer use and no ITLC (Type IV). Type III and IV sites were comparison sites for the ITLC sites. Figure 2, on the following page, shows the study's design. Type I, II, and III classrooms were studied during the first year. The names of the schools have been changed and may or may not refer to the actual site.

New classrooms and a Type IV classroom were added in the second and third year. In the year following participation as a Type III classroom, the room became a Type II classroom. This arrangement was made with teachers in return for their initial participation as a comparison site. We originally intended that the Type IV classroom in Year 2 would become a Type I classroom in Year 3; however, the teacher planned to take maternity leave during the year, the administrator was not supportive, and their computer arrived five months later than the principal had promised. Therefore, that location was dropped from the study.

Figure 2. Progression of Sites through Phases 1,2,and 3



The ITLC was administered by research staff in collaboration with the teacher during a classroom's first year of participation. The second and third year of participation the teachers were responsible for carrying on the ITLC with support and consultation from the research staff. After analysis of first year data, we determined that the presence of the research staff, administering the ITLC, had an immediate positive effect. When teachers were responsible for the ITLC, positive effects were more evident in the third year rather than in the second. Subsequent data analyses took this factor into consideration.

Subjects

Children. Two hundred and fifty-five 3, 4, and 5-year-old children who demonstrated mild to moderate disabilities, the staff who served them, and their families, were studied. Table 1 shows numbers of children involved in the Project by Site and Year. Seven children were dropped from the study because families moved. Twelve children participated across the first 2 years,

Table 1. Numbers of Children by Site and Year

	Fox Lake	Middlebrook	Medland	Deer River	Johnstown	Barretville	West Marlin	Elberton		Grand Total
Year 1	23	25	14							62
Year 2	23	24	12	24	26	19				128
Year 3	19	22	11	17		15	15	14		113
Total	53	58	27	35	25	28	15	14		255
Repeat Children	*3 **6 ***3	*5 **6 ***2	*4 **4 ***2	**6	**5				*12 **27 ***7	46
Cross-site Children					#1	#1				2

* Yr 1 + 2
** Yrs 1 + 2 + 3
*** Yrs 1 + 2 + 3
# The children participated in aYear 1 site. Their families moved to a different participating site for Year 2.

while 27 participated across the second and third years. Seven children participated for 3 years. These children are identified as 'Repeat Children' in the section on results and discussion. Two participants from an ITLC participating classroom were followed to a comparison classroom when the families moved. Table 2 shows the distribution of children across experimental and comparison treatment groups.

Table 2. Distribution of Children Across Experimental and Treatment Groups

YEAR 1	ITLC + Staff		ITLC				TECH Only		No TECH	
			A		B		C			
Age	M	F							M	F
3	10	3							2	2
4	15	9							4	0
5	4	2							4	2
6	0	0							0	0
Total	**29**	**14**							**10**	**4**
YEAR 2										
Age	M	F	M	F	M	F			M	F	M	F
3	3	6	1	3	4	0			1	2	2	1
4	10	10	9	8	9	6			4	4	8	7
5	4	1	1	0	2	0			2	2	2	2
6	0	0	0	0	0	0			0	0	0	0
Total	**17**	**17**	**11**	**11**	**15**	**6**			**7**	**8**	**12**	**10**
YEAR 3												
Age	M	F	M	F	M	F	M	F	M	F	M	F
3	1	2	0	0	2	0	5	1	1	0	2	1
4	3	4	5	7	5	3	15	9	4	0	2	3
5	2	2	2	2	0	2	8	1	4	1	2	2
6	0	0	0	0	0	0	1	0	0	1	1	0
Total	**6**	**8**	**7**	**9**	**7**	**5**	**29**	**11**	**9**	**2**	**7**	**6**
	M	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**
Grand Total	**52**	**39**	**18**	**20**	**22**	**11**	**29**	**11**	**26**	**14**	**19**	**16**

Children in the classrooms were classified either as eligible for Early Childhood Special Education or Prekindergarten At-Risk Programs (Pre-K). Both categories were included within classrooms. Guidelines for admittance to the Early Childhood Special Education and Pre-K at-Risk programs meet Illinois state guidelines although eligibility is defined in flexible terms. If, through diagnosis and assessment, a child is classified as Early Childhood Special Education, the child has an Individual Education Plan (IEP). IEPs are written for any physical impairment,

including vision and hearing. IEPs can also be written if a child has significant developmental delays. The term 'significant' is defined by the school district. Some school districts classify children as Early Childhood Special Education if the child is in need of speech service, but other school districts do not.

School districts which have state-funded Pre-K programs must develop eligibility criteria and conduct screenings. After criteria have been established, the school district then determines which children are eligible. Criteria can include socio-economic conditions such as having a single parent, having a sibling in special education, having a sibling who has been retained, being a twin, living in a rural area, or having a low income level. Pre-K programs also include speech and motor delays as a part of the criteria if it is not part of the Early Childhood Special Education criteria. Most school districts require the presence of at least two of the established criteria if a child is to qualify for Pre-K.

Preschool Staff. Eight teachers, 24 support staff, and 226 families participated in the study which was conducted in public school settings with all the concomitant problems related to bus schedules, illness of both teachers and children, holidays, snow days, families' moves and problems, lack of space, changing program assistants, and assistants who were indifferent to the goals of the project. The teachers were experienced in early childhood special education with a range of 7 to 21 years in the classroom. All held degrees in either early childhood or special education, agreed to participate, and were recommended by their principals as being effective teachers. Four of the eight teachers held Master's degrees.

Teacher interactions with children occurred in varying degrees. Three teachers (Fox Lake, Barretville, and West Marlin) acted as facilitators for learning and encouraged children to explore, create, and problem solve. Children in these sights directed their own play. Three teachers (Middlebrook, Deer River, Johnstown) exhibited a 'mixed' approach. Although they offered children choices and facilitated their learning during center time, interactions were adult directed during structured activities. The remaining two teachers (Medland and Elberton) directed all of the children's daily activities. Children were not encouraged to question, share, or explore. These two teachers emphasized product rather than process.

Families. Across the experimental groups, families shared similarities not only in terms of education and employment, but also in reading and writing practices. Across classroom types, 75% or more of the 203 families who responded to our *Family Literacy Questionnaire* indicated that two parents lived in the home. Most parents read some form of book, newspaper, or magazine daily and subscribed to either a local newspaper or an entertainment magazine. Twenty-five to 37% of families subscribed to children's magazines. Most families obtained books to read from stores or through mail order, perhaps due to the geographic location of their communities. Four communities did not have a readily accessible public library. Although many sources were

described as being used to obtain books, the technology only group had a higher percentage of families who did not obtain books from any source (15%) and 55% indicated that their children did not request new books or trips to the library. However, more than 60% of the families in the remainder of the groups reported that their children requested new books or trips to the library.

A high percentage of families in the ITLC conditions reported that they had over 100 children's books in their home. The remainder of the families in the technology only or no technology groups had fewer books, with between 11 to 50 children's books. When asked how often a family member reads to a child, across classroom types, 50% or more responded that a family member reads to the child every day. Although more than 50% of the families, across classroom types, reported a regular reading time, the ITLC plus research staff groups had the highest percentage with 72%. Families also reported that most children 'read' (pretended to read) aloud to a family member either every day or frequently, across classroom types, except for the families in the technology only classroom. The families in this group reported that their children never or seldom 'read' aloud.

From 28% to 63% of the mothers had completed high school and some (13% to 43%) had further college or technical school training. In the ITLC plus research staff groups, 41% of the mothers had completed high school and 30% had technical training. In the ITLC only (where teachers implemented the curriculum), only 28% of the mothers completed high school and 43% had some college or technical school. In the no technology group, 63% of the mothers had completed high school and 13% had further training. Whether or not the mothers completed high school did not affect their children's literacy behaviors as much as the children's interaction with the ITLC, particularly when the research staff implemented the curriculum.

Forty-four (44%) percent to 56% of the fathers, across classrooms, had completed high school, while 7% to 19% had completed further college or technical school training. In the ITLC plus research staff groups, 56% of the fathers had completed high school with 14% reporting further training, while 49% of the fathers in the ITLC only group had completed high school with 19% experiencing further training. In the technology only group, 44% of the fathers had completed high school and 7% had further training. In the no technology group, 56% completed high school and 3% had further training.

The majority of parents' occupations (from 24% to 54%) fell into the unskilled category. Most parents were employed. Only 1% to 6% of the fathers were unemployed. Twenty-two percent (22%) to 33% of the mothers were not employed outside the home.

Classrooms

All eight sites housing 16 preschool classrooms were located within public school buildings in rural or small city settings. Figure 2 showed the progression of sites and treatment groups across

the 3 years of the study. Three sites, Medland, West Marlin, and Elberton, were housed in buildings that contained early childhood classrooms exclusively. Although all the classrooms housed children from age three to five with mild to moderately severe disabilities, variations occurred in facilities, teachers' approaches, and daily activities.

Two of the eight sites, Johnstown and Elberton, did not use technology; therefore, a computer center did not exist. Of the remaining six classroom sites, three were control or comparison sites for one year (Medland, Barretville, and West Marlin). Two of these three sites (Medland and West Marlin) limited children's time at the computer for five to ten minutes, and children's turns were managed by the teacher. During the ITLC implementation, four of the six sites—Fox Lake, Middlebrook, Deer River, and Barretville—consistently provided a child-directed environment at the computer. Children directed their own turn taking and turn length, made program choices, and changed CD-ROMs. In these classrooms, the computer center became "just" another center. Adult direction was observed more frequently in the other two sites. Turn taking and length were directed by the teacher at various times. However, these teachers did provide software choices for the children.

Classroom environments in six out of eight sites[4] —Fox Lake, Middlebrook, Deer River, Johnstown, Barretville, and West Marlin—were developmentally appropriate and had defined centers, space for children to move freely, ample toys and materials, and displays of children's work. Middlebrook's room size was small, causing the centers to be less defined and more crowded.

In contrast to these six sites, the remaining two sites, Medland and Elberton, provided the children with few materials and toys. Tables, chairs, and teacher desks dominated the classroom environment. While two or three centers were available to the children, very few materials and supplies were accessible. The Medland site was decorated around themes related to holidays, and children's work consisted of ditto pages. The Elberton site did not display decorations or children's work. However, these two sites had large spaces and windows.

All sites provided center time or free play with time periods ranging from 20 minutes to 1 1/2 hours. Medland and Elberton had greater teacher-directed interactions during free play periods. In these sites, the centers were not a free choice. Selected activities were planned then completed by each child. The other six sites provided materials and equipment for child-directed play. The materials for the different centers were changed according to theme units in three of the eight sites. The others occasionally rotated materials and supplies.

Five sites—Deer River, Johnstown, Barretville, West Marlin, and Fox Lake—integrated small groups into their daily activities. Four of the five used small groups during center time or free

[4] Names of sites have been changed and may or may not refer to the actual site.

play. In Deer River, Johnstown, and Medland, children were required to complete teacher-directed activities before they could participate in the centers. Fox Lake's small group activities were not daily events but were used periodically for craft activities. Barretville's small group time was separate from center time. Activities were adult facilitated rather than adult directed.

Circle time was a part of each day's schedule in seven of the eight sites, with the exception of Middlebrook. All circle time activities were similar in content. Content included calendar, weather, helpers, singing, fingerplays, and/or sharing. Storytime occurred during circle time in each of the classrooms. Middlebrook had a daily circle time during Year 1; however, during Years 2 and 3, Middlebrook's circle time was scheduled sporadically.

Children's involvement in the circle time activities differed from site to site. During circle time in one classroom, children could respond freely, share ideas, and give suggestions. In another classroom, children were expected to give appropriate responses or recite phrases. For example, when doing a calendar activity, children were to respond, "Today is Wednesday, November 2." In other classrooms, children could say, "Wednesday."

The presence of materials to promote literacy varied across classrooms. Over one hundred books were available for the children in six out of eight sites, the exceptions being Medland and Elberton. Books were rotated around themes with selected titles displayed and a comfortable area was available in each classroom for children to explore books. Neither Medland nor Elberton made books available to the children. After Medland implemented the ITLC during Year 2, the teacher began to provide a small number of books for children's use during Year 3. No writing materials were accessible to the children nor was a writing center in evidence in either Medland or Elberton. The remaining six teachers provided an ample supply of paper and writing tools for children's exploration and an area that was designated for writing.

Outdoor and gym time for children's physical activities was available in all but two sites. Medland and Deer River, provided only gym time. Children in Medland went to the gym daily. The Deer River classroom's gym time was scheduled twice a week for half an hour with the physical education teacher.

Procedures

Research staff were assigned to each Type I, II, and III site on a staggered schedule for periods of 2 weeks to a month during the site's first year in the study. Two researchers went to a site. One person rotated to another site in 2 weeks while the other remained for an additional 2 weeks, and a third rotated in to remain for a month. The rotation controlled for individual researcher characteristics as each element of the ITLC was administered and provided a degree of continuity in each site. Researchers spent four times a week from a half day to a full day in the first year sites.

The order of each section of the ITLC was varied during each site's first year of participation. During the second year of participation, classrooms that had previously implemented the ITLC with research staff, but now implemented the ITLC on their own, offered all sections of software together. This change was made after teachers and children requested free access to the different types of software. The first year an ITLC classroom entered the study, the research staff modeled implementation of the ITLC while the teachers and staff observed and assisted but were not responsible for conducting activities.

During the second and third years, when a site moved into the Type II category and additional classrooms were added to the study, visits to the classroom decreased to once a week. Researchers rotated every three weeks in the second year. In the third year, visits to classrooms in the Type II category decreased to twice a month because researchers and auditor alike agreed that data collection had reached redundancy. The research staff continued to collect information through observations, field notes, and videotapes. If new information was collected on any visit, the frequency of the visits would increase to collect the new information. However, new information was not found, and observation checks continued to support earlier findings. Comparison sites were visited two to three times a month. Video cameras were used to document classroom observations. Table 3 displays the number of observations made according to experimental treatment over a 3 year period.

The research team convened weekly to discuss data collection activities and the information gathered during the week. They reviewed videotapes, discussed progress of individual children, shared anecdotes, solved problems when necessary, and planned data collection questions for the following week. On site, staff videotaped activities and took field notes on AlphaSmart Pro keyboards. When staff returned to the research office, the field notes were downloaded into a word processing program on office computers. Videotapes were compared to field notes as part of the triangulation process and provided a method to check interpretations and maintain the integrity of the data over time. Questions that arose from field notes, video tapes, and staff meetings were discussed with teachers and staff as part of the member checking process. After each site visit, research members recorded memos as part of their field notes or in separate journal entries. The information in the memos was discussed regularly in staff meetings and in separate meetings with the coordinator of the research team as each member explored aspects of the inquiry that might otherwise have remained only implicit in the inquirer's mind. The purpose of the debriefing sessions with the coordinator was to probe biases, explore meanings, and clarify interpretations.

As part of the data collection process, families were interviewed both formally and informally. During site visits, the research team worked closely with classroom teachers to arrange family interviews. The family interviews were conducted in homes or at school, depending on the preference of the family and their work schedule. Research staff talked to family members visiting the classroom, during open houses, and at scheduled family events. At the beginning of

Table 3. Number of Observations by Days According to Experimental Treatment Over a Three Year Period

		Number of Observations			
Research Year	Site	Technology+ ITLC+Staff	Technology+ ITLC	Technology Only	No Technology
Year 1	Fox Lake	70			
	Middlebrook	75			
	Medland			22	
Total Year 1		145		22	
Year 2	Fox Lake		29		
	Middlebrook		24.5		
	Medland	88			
	Deer River	95			
	Johnstown				17
	Barretville			18	
Total Year 2		183	53.5	18	17
Year 3	Fox Lake		18		
	Middlebrook		17.5		
	Medland		12		
	Deer River		14.5		
	Johnstown				
	Barretville	57			
	West Marlin			15	
	Elberton				8
Total Year 3		57	62	15	8
TOTAL		385	115.5	55	25

each year, a family literacy questionnaire, *Reading, Writing, and Computers*, was sent home with each child to be filled out and returned. The questionnaire recorded information about the reading and writing behaviors of the child and family and gathered general information about the family. At the end of the year, a simpler form, *Kids and Computers*, was sent to families along with a videotape recording their child's progress from the beginning of the year to the end of the year while involved with the ITLC. The form, which gathered information about changes observed in children, was packaged with markers and drawing paper so parents could encourage children to draw and talk about what they liked best about the computer. The completed papers and the videotapes were returned to the classroom teacher and collected by the research team.

All project teachers, support staff, and administrators were invited to the campus of Western Illinois University once each year for a presentation of preliminary results, to share information and gain feedback. The presentations incorporated pictures, video, and software programs used and created in the classroom. The event produced successful information exchanges among the research staff, teachers, and administrators. Workshops conducted regularly on campus again provided feedback as teachers discussed, with the research staff and other teachers, what was taking place in their classrooms with technology use. At the end of each year, a half day was set aside for the research staff to meet with the ITLC teachers as a group for a member checking meeting. Data from the previous year was summarized and problems and issues that arose over the year were discussed.

The Interactive Technology Literacy Curriculum

The ITLC provides a framework organized to assist young children to develop emergent reading and writing. ITLC activities were designed to promote literacy development at the computer center as well as in other areas of the environment and other curricula areas. In addition to strategies to acquire and develop language pleasantly, productively, and appropriately, the ITLC highlights the importance of children's home cultures and builds upon uses of language and literacy through existing home experiences.

Macintosh Performa 636 computers with internal CD-ROM drives, 14" - 15" monitors, and color inkjet printers were used. A description at the beginning of each activity explained the links between the software and children's learning. Three types of software were used in the version of the curriculum now available: (1) interactive commercial software which can be used to extend literacy concepts and behaviors including the Living Books series such as *Just Grandma and Me*, *Harry and the Haunted House*, and *Stellaluna*; (2) commercially available graphics and story-making software such as *Kid Pix 2*, *EA*Kids Art Center*, and *Stanley's Sticker Stories*; and (3) *HyperStudio*, an authoring program used by teachers and children to develop their own software based on meaningful experiences such as a favorite story, a description of the children and their classroom, art work, a field trip to the veterinarian's office, and information and photographs of children's families.

A fourth type of software, *HyperStudio* stacks produced by other classrooms, was tested during the study with mixed results. Software was highly personal to the particular classroom where it was produced. Although the children who participated in making the stack went back to it over time, generally children in other classrooms were not interested in others' productions. Success of these stacks depended on the nature of the content and the interest of the teacher or researcher. The content and production techniques for the stacks elicited more interest in the children who were actually making the stacks than in other viewers in distant classrooms.

Criteria were designed to analyze commercial software in terms of five levels of interactivity. Figure 3 lists software in each of the levels. Software used initially by the research staff was also evaluated on the basis of two more different types of evaluation methods; a checklist regarding overall quality and appropriateness for the age group, while the other was based on instructional design, technical characteristics, and ease of use. The qualitative evaluation checklist contained statements such as, "The software encourages active involvement," and "The child controls the process." The second examined instructional design, educational value, and usability. Sample items included, "Rate and levels of difficulty can be adjusted for users;" "Program moves from level to level;" and "Graphics, sound, and color are utilized."

After undergoing systematic evaluation, selected software was based on a theme, event, or project that was occurring within the classrooms (e.g., *How Things Work in Busytown* was used in a classroom to support a "farming and grain" theme). Children were offered four to five choices of software titles, and the choices were rotated on a regular basis. Many titles in the Living Books Series, including *Harry and the Haunted House, Stellaluna, Just Me and My Dad,* and *Just Grandma and Me* were used and enjoyed by children.

Classroom Management

Classroom management methods were designed to integrate literacy activities during group time and free choice. *KidDesk* was used to manage computer desktops in order to give children the opportunity to access applications on their own. Running *KidDesk* automatically provides maximum hard disk protection while allowing children independent access. Teachers can customize *KidDesk* for individual children through the adult options.

Management strategies included appropriate placement of the technology center, facilitating children's independent management (to the extent possible) of the computer center, and supporting groups of computer users in order to promote socialization, oral language, and turn taking. Sign-up sheets were used to encourage turn-taking and independent use of the computer. Each child was expected to make a distinguishable mark that identified him or her. They were not expected to write their names in manuscript format. Sign-up sheets were dated and served as part of the data collection.

Software titles that supported both literacy and the classroom curriculum were selected through careful review, described above. Software titles appealed to the wide range of abilities in a class, provided for differences in children's learning styles, and supported activities in the reading center, other areas of the classroom, and at home.

Figure 3. Software Levels Of Interactivity

Level 1 Minimal choices Specific path Fixed response No control of text Very limited control of sound; on/off No control of graphics	• *Animal Tales* • *Camp Frog Hollow* • *Circletime Tales* • *Claws for Alarm:* • *Eensy and Friends* • *Five Green and Speckled Frogs*	• *Monkeys Jumping on the Bed* • *My Favorite Monster* • *New Frog and Fly* • *Rosie's Walk* • *Storytime Tales*
Level 2 Multiple choices Predictable path Varied responses No control of text Very limited control of sound; on/off No control of graphics	• *Arthur's Birthday* • *Arthur's Reading Race* • *The Backyard* • *Bailey's Book House* • *Berenstain Bears Get in a Fight* • *Berenstain Bears in the Dark* • *Dr. Suess's ABC* • *Franklin Learns Math* • *Harry and the Haunted House*	• *Jump Start Toddlers* • *Just Grandma and Me* • *Just Me and My Dad* • *Little Monster at School* • *McGee Series* • *The Playroom* • *Preschool Success Starter* • *Sheila Rae the Brave* • *Stellaluna* • *Tortoise and the Hare*
Level 3 Multiple choices Moderate control of path Varied response No control of text Very limited control of sound; on/off No control of graphics	• *A to Zap* • *ArtSpace* • *Busytown* • *Cat in the Hat* • *Darby the Dragon* • *Green Eggs and Ham* • *Gregory and the Hot Air Balloon* • *How Things Work in Busytown* • *Just Grandma and Me 2.0* • *Just Me and My Mom*	• *Let's Explore the Farm* • *Let's Explore the Airport* • *My First Amazing World Explorer* • *My First Incredible, Amazing Dictionary* • *Putt Putt Joins the Parade* • *Putt Putt Goes to the Moon* • *Ruff's Bone* • *Sammy's Science House*
Level 4 Multiple choices Total control of path Varied responses Total control of text Limited control of sound Limited control of graphics	• *Amazing Animals* • *Amazing Writing Machine* • *Big Job* • *Chicka Chicka Boom Boom* • *ClarisWorks for Kids* • *Crayola Art Studio* • *EA*Kids Art Center* • *Explore-A-Story Series* • *Gryphon Bricks*	• *Kid Pix Studio* • *Kid Works 2* • *Kid's World* • *Playskool Puzzles* • *Stanley's Sticker Stories* • *Stone Soup* • *Storybook Weaver* • *Thinkin' Things Collection* • *Tonka Construction*
Level 5 Choices limited by child Control of path Responses limited by child Control of text Control of sound and sound effects Control of graphics Integrated content	• *Blocks In Motion* • *HyperStudio* • *Kid Desk Family Edition* • *Logo*	

Site Staff Development

Each year three formal training sessions were held for teachers and program staff (program assistants and speech therapists) in Type I and II classrooms. Sessions were scheduled in late August, late January, and early May. Workshops were designed for teachers with basic to expert knowledge of technology. Specifically, separate inservices for site teachers in each Type classroom, organized according to the teachers' needs, were conducted at WIU in August. One inservice was held to prepare teachers in the Year 1 Types I and II sites for Phase 2 of the research. Another inservice was conducted for the teacher from the Year 1 Type III site. Since this site was an observation site during Year 1, the inservice prepared the teacher and aides to implement the ITLC in the second year. The Year 2 Type III and IV sites did not have formal inservice training. Instead, informational meetings were conducted in each classroom with the teachers and aides to explain their roles and to outline procedures. A full day inservice date was scheduled for late Spring for teachers in the Type I and II sites where technology training was continued.

Workshop topics included Getting to Know Your Hardware, *KidDesk*, Evaluating Software, *HyperStudio*, and *ClarisWorks*. The following workshops consisted of hands-on training, where participants were in front of a computer. Getting to Know Your Hardware included information on installing software, using a scanner, using a QuickCam, navigating the desktop, troubleshooting printer problems, and properly shutting down the computer. *KidDesk*, a desktop management program, was the focus of one training session.

Teachers were given an overview of software features and then given time to explore the accessories. During training sessions on evaluating children's software, discussions were held about literacy activities that complemented the software programs, thereby creating curriculum activity ideas that teachers could take back and use in their classroom. Appropriate and inappropriate software titles were reviewed with teachers and staff, giving them the opportunity to discuss positive and negative features of software programs.

HyperStudio workshops were designed to give teachers an overview of the program, to explain basic components, to provide hands-on practice of procedures, and to evaluate stacks for effectiveness. Teachers were encouraged to work with children to create stacks which were based on interests of the class. Training on *ClarisWorks* was done to give teachers the basics of word processing, data bases, and spread sheets. *ClarisWorks* was the application of choice because it came already installed on the Macintosh computers used. Teachers received hands-on experience creating newsletters, mailing lists, and records for each child.

Training also occurred in an on-going, informal process, often accomplished when research staff were at the sites. Researchers worked informally with teachers and support staff on a one-to-one basis during lunch, breaks, and after school at the staff's request. They answered general

questions, demonstrated software and computer use, discussed child progress, and provided other information or computer expertise as needed. The informal sessions lasted from 15 minutes to an hour, depending on teacher needs. Research staff were available on Fridays for any teacher who requested additional services. Technical assistance was available by phone anytime.

Family Participation

Initially parents were informed about the Project and their children's activities by letter or meetings. Permission forms for participation, videotaping, and information release were secured and are on file for all children in every participating classroom. Families were offered several ways to participate in the project. Awareness activities were informational in nature. Newsletters and notes about the importance of emergent literacy and activities to try were sent home. Family Night literacy sessions and classroom activities were incorporated so families could observe and/or work with children. Family members enjoyed leaving e-mail and voice mail messages on *KidDesk* for their child. Families were invited into the classrooms to work with the technology. Videotapes documenting children's use of the ITLC were also provided for families. They also participated in evaluation activities.

Assessment Materials

Figure 4 lists and describes the array of research instruments used in the study. Data came from observations, videotapes, field notes, interviews with teachers and families, checklists, and samples of children's writing. Copies of instruments not otherwise available are contained in Appendix A.

Child. Pre-post measures included the *Informal Literacy Assessment (ILA)* measure, Clay's *Concept about Print Test*, and the *Behavior Interaction Tool (BIT)*. The measures were selected or developed at the study's onset, tested in the University Preschool Center, and revised. Then an Expert Panel evaluated the instruments before use in the study and suggestions for revisions were incorporated into the instruments.

The *BIT*, originally developed as a checklist to collect relevant data on children engaged in computer intervention activities, was revised to record only positive behaviors found at the computer center. It allowed for children's behaviors to be recorded with a peer(s), an adult, and while using the computer alone. All *BIT* observations were recorded over a 2 to 3-day period.

The *ILA* instrument itself was not changed from the original version. However, the way it was administered was changed from a pull out, isolated test in the school library or classroom to a more relaxed and appropriate testing situation in the classroom during center time. This allowed the research staff to observe and record children's more natural literacy behaviors within the context of the everyday environment. The *ILA* was devised using elements of existing preschool literacy measures by Dyson (1982), Katims (1991), Strickland (1990), Sulzby (1986, 1988), and Teale & Sulzby (1986).

Figure 4. Summary of Research Instruments

Research Instrument	Teacher	Child	Family
Teaching Style Checklist: A checklist designed to record at teaching styles and developmentally appropriate practices. Researchers completed a checklist for each teacher. This same checklist was given to the teachers for self evaluation. The checklist was completed in Year 2 and Year 3.	●		
Teacher Literacy Questionnaire: Teachers completed the form at the beginning of each research year. The form reflected competencies in emerging literacy and descriptions of the classroom literacy environment.	●		
Teacher Interviews: Interview questions focused on the benefit of the ITLC for children. Teachers were asked to comment on the positive effects as well any concerns regarding the ITLC. Interview were conducted each year.	●		
Training: Training sessions were conducted with teachers and support staff. Workshop evaluations were completed by participants to provide feedback	●		
Site Descriptions: Researchers contributed a description of each site participating in the study. Descriptions were combined and summarized for each site	●		
Networking Minutes/Information from Networking: Networking opportunities for teachers, administrators, and support staff was provided each year	●		
Video Tapes: Researchers video taped each classroom observation of children participating in the ITLC. Video focused on children at the computer	●	●	
Interesting Incident Report: Teacher and/or support staff recorded interesting incidents involving literacy and computer behaviors.		●	
Field Notes: Extensive field notes were taken at each classroom visit by researchers. Field notes recorded information; number of children present, adults present, software being used, other activities available, classroom atmosphere, and peculiar circumstances. The majority of the field notes consisted of recording literacy behaviors at the computer. Notes were made regarding literacy behaviors outside of the computer center as well.	●	●	
Memos: Reflections regarding observations and occurrences in the classroom were recorded by researchers. Researchers expressed impressions and interruptions of activities and behaviors observed.	●	●	
Sign Up Books/Sheets: Sign Up books/sheets were collected from each classroom.		●	
Informal Literacy Assessment (ILA): A twelve (12) question checklist used to assess children's emergent literacy behaviors at the beginning and end of each research year.		●	
Behavior Interaction Tool (BIT): Checklist to determine children's interactions at the computer and their technology literacy at the beginning and end of each research year.		●	
Sign Up Books/Sheets: Sign Up books/sheets were collected from each classroom.		●	
Children's Drawing and Writing Samples: Samples from each classroom were collected.		●	
Kids and Computers Evaluation: A two part evaluation was sent home with children at the end of each year. Four questions asked parents to evaluate the impact of the research study on literacy. A one question page, "What do you like best about the computer?" was included for child feedback. The child responded with drawings, writings, and/or dictation.		●	●
Family Literacy Questionnaire (FLQ): Questionnaire designed to evaluate literacy environment of the home. Complete and returned by families at the beginning of each research year.		●	●
Family Interviews: Once a year, formal interviews were conducted with at least two families at each site. Parents were asked questions to reflect on the literacy environment of the home. Questions regarding changes in children's literacy and computer behaviors were asked. Informal interviews were conducted throughout the year during school events and when family members visited classrooms.		●	●
Expert Panel Meetings: Minutes from expert panel meetings conducted three times a year were transcribed.			●

Clays' *Concept about Print Test* is a standardized test used in evaluating children's knowledge of print. However, it proved to be geared to older children and inappropriate for the ITLC study's sample of children. Its use was discontinued after the first year.

Teachers used "interesting incident reports," written on 4 by 6 inch cards, to record incidents or children's behaviors of interest to the study during Years 2 and 3. The cards were dated and collected weekly by research staff. The incident reports were part of the agenda at weekly staff meetings. Questions that arose were discussed and noted for follow-up during subsequent visits. Information taken from incident reports was entered into the database.

Teachers. The *Teacher Learning Styles Checklist* was used in the second year to record behaviors of teachers in the study. The checklist was adapted for our purposes from Missouri's *Standard and Procedures for Voluntary Accreditation of Early Childhood Education Programs.* The checklist contains 86 statements with yes, no, and not observed responses along with space for remarks and examples. The *Teacher Learning Styles Checklist* was used to provide a triangulation method for observations and videotape as the Research Associates recorded teacher behaviors in the classroom. The checklist was filled out by each teacher and each ITLC Research Associate. The Research Associates' scores were recorded and averaged. The scores recorded on the checklist supported observations, videotape sessions, and reports during staff meetings.

The instrument evaluates the teacher's and staff members' interactions with children, developmentally appropriate curriculum practices, the physical elements of the classroom, and family involvement. Sample statements on the checklist include:

- learning objectives/expectations are modified to accommodate children's individual abilities, learning styles and needs;
- daily plans include individual experiences; all children are helped to acquire and use language to communicate information, thoughts and feelings, and to talk and listen with understanding;
- books are available to children for use during free choice during each day;
- staff relates to children in positive ways by evidencing pleasure and enjoyment in working with children;
- staff sustain from corporal punishment or other humiliating or frightening discipline techniques;
- family members have opportunities to be involved in the ongoing program with their children in some of the following ways (celebrations, field trips, sharing expertise, skills, interests, and family customs, sharing a meal/snack, assisting in the classroom, special projects).

Results are provided in the section of this report titled *Differences in Teaching Styles Among Staff* on page 68.

Families. The *Family Literacy Questionnaire (FLQ)* and *Kids and Computers Evaluation* were two instruments used with families. The *FLQ,* which was completed and returned by families at the beginning of each year, was designed to evaluate the literacy environment of the home. The questions were developed to reflect literacy activities of both parents and children while at home. Sample items on the questionnaire include:

- How often do you read books?
- Where does your family obtain books?
- How old was your child when you began sharing books with him/her?
- Does your child try to print letters, words, or stories?
- Do you use a computer?

The *FLQ* also asked parents to provide information about their education and current occupation.

At the end of each year, a two part evaluation, the *Kids and Computers Evaluation*, was sent home. The survey contained four questions which evaluated the impact of the research study on the child's literacy behaviors. The evaluation asked for parents to respond to the following questions:

- What does your child say about the computer at home?
- Have you seen a change in the way your child uses books?
- How does your child involve writing in play at home?
- How do you feel about the computer being in your child's classroom?

A one-question page, "What do you like best about the computer?" was included to gather children's reflections about the computer. Children responded with drawings, writings, and/or dictation.

Family interviews were used to gather information from parents about their children and literacy. Once a year, formal interviews were conducted with at least two families from each site. Parents were asked questions to reflect on the literacy environment of the home, changes in children's literacy behaviors, and observations regarding computer interactions. Informal interviews occurred throughout the year from contact with parents during school events, classroom visits, and chance meetings outside of the classroom.

The Project's Expert Panel also contained a family component. One parent served on the Expert Panel, which convened three times a year. Her input and perspective provided valuable information not only to Project staff but also to the university faculty, teachers, and other professionals who served as Panel members.

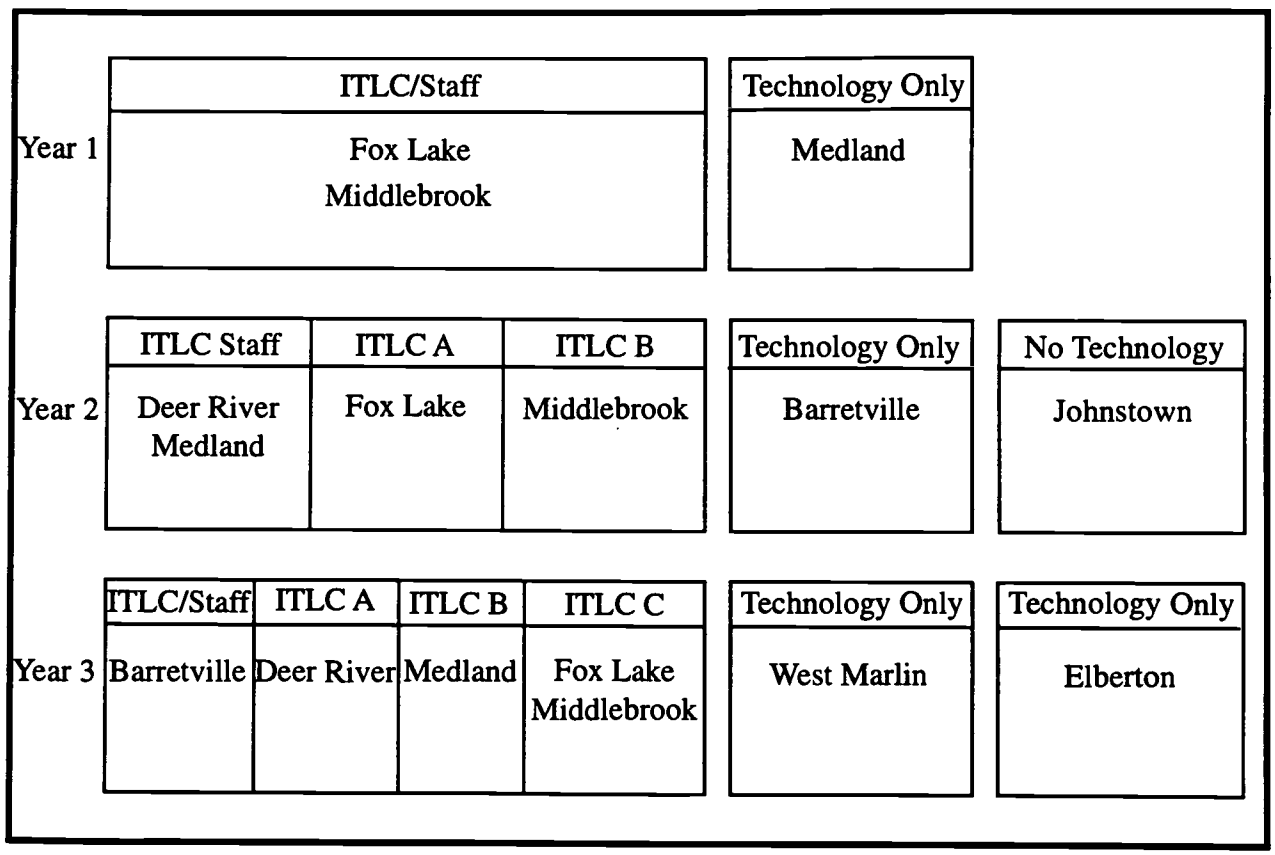
Data Analysis

Both qualitative and quantitative data analyses occurred, according to the nature of the data. Because of the sheer amount of data collected and the importance of the information to the field, further analyses on selected variables continue. Data triangulation was accomplished as comparisons were made among family and teacher interviews, incident reports, videotapes, field

notes, questionnaires, test scores, and IEPs. The research team maintained reflective journals to document the evolution of the study's emerging design.

First year data analysis showed similar behaviors in children across ITLC classrooms—whether or not the teachers were experienced technology users. The research staff actually carrying out the ITLC within classrooms was determined to be an important factor in the effectiveness of the treatment. Therefore, for purposes of data analysis, the ITLC classroom types were divided in order to look at effects in more detail as shown in Figure 5. Type I included classrooms where the research staff implemented the ITLC. Type II included second and third year Type I classrooms divided into (A) teachers new to technology and (B) experienced technology users. ITLC (C) included classrooms that participated in the ITLC for three years and implemented the ITLC for two years on their own. Type III remained as classrooms where technology was used without the ITLC and Type IV did not use technology.

Figure 4. Types of Classrooms Divided to Examine the Effects of the ITLC



A coding system was developed using the research questions as a basis. Observation instruments were developed and tested at the beginning of the study. After initial site visits, the instruments were revised and included in a binder with lined paper, notebooks, calendar, and daily logs along with a suggested format for field notes. Observable behaviors were revised to include the following:

- looking at or reading books;
- listening to stories;
- identifying environmental print;
- using print in dramatic play;
- writing with invented spelling;
- describing characters in a story;
- retelling a story;
- articulating key concepts of the story;
- using illustrations to tell a story;
- labeling items;
- verbalizing while scribbling and drawing;
- using books, pencils, and paper in dramatic play;
- dictating stories;
- using appropriate syntax;
- increasing vocabulary;
- predicting story sequence or outcome;
- recognizing letters;
- identifying words; and imitating reading.

An outline of the coding system is contained in Appendix B.

Fourth Dimension, a dimensional database, was used to categorize and link data. Unlike a traditional flat database, the dimensional element allows working with files interchangeably within the database by linking transcribed field notes with the codes entered into the database. It functioned as expected in terms of the intended purpose.

Trends or patterns in the data were determined by the entire group of researchers reviewing data contained in each code. Not only research staff observed these behaviors that comprised trends, but teachers and parents reported similar observations and perceptions. The research staff identified coded behaviors that occurred repeatedly, across classrooms and across children, at different times, then discussed their findings and came to consensus within the group. Identifying trends was a time consuming, tedious process, based on all the data entered into the coding system.

VII. Problems and Solutions

The study did not depart from the original objectives or planned activities. Training the research team to use a qualitative approach in an area where only a rudimentary road map existed was time consuming but critical to the results. Any researcher attempting a qualitative study should be prepared to spend many hours in collaborative training and review as work progresses.

A personnel problem occurred during the first year because one of the researchers proved to be too directive in her observations and interactions with children. Her behavior interfered with the study's purpose. Further training, individual consultation, regular and frequent staff meetings, and other methods of correction were attempted but ineffectual. After the first year's data audit, this person was removed from the research team and a new individual joined the study. Although hiring and training a replacement required an unexpected expenditure of time, the problem was solved.

Fourth Dimension presented unexpected technical problems that resulted in a system crash and delay in entering field notes. Adding RAM memory to the machine solved the problem. The program also took far longer for staff to learn to use than expected and required continual technical support from the manufacturer.

The research staff expected to handle massive amounts of data, but at times during the study, the staff members felt overwhelmed by the amount of data they were collecting, analyzing, and attempting to summarize. Copious data is both a problem and a blessing in qualitative studies. During the second year research audit, the auditor and research staff determined that redundancy had been reached in observing and videotaping children's behaviors centered around the ITLC. Behaviors were being observed over and over again or not observed at all. Trends or categories not observed across all classrooms included 'describes characters,' 'retells a story,' and 'dictates stories.' Children could retell parts of stories and could dictate parts of stories; however, for categorization purposes, a story was defined as having a beginning, middle and end. Children could retell or dictate an entire story when prompted, but this behavior was one that did not occur naturally within a classroom.

The situation was discussed during the audit. At that time, the researchers and auditor decided that it was highly likely that no new information could be gathered from observations of children within the classroom. To support this decision, the following plan was implemented. Staff would continue to visit classrooms one to two times a month to determine whether new behaviors occurred. If new behaviors were observed during the visits, the behaviors would be discussed in a weekly staff meeting and the researchers would decide whether they should continue classroom observations at closer intervals. However, after 2 years of classroom observations, no new behaviors were observed. The research staff maintained contact with teachers via phone, mail, and interesting incident reports. Additional information gathered included pre-post tests,

questionnaires, surveys, and interviews gathered from children, teachers, school staff, and families. These data were entered into *Fourth Dimension* and continued to support the data gathered during observations by staff.

The technical problems related to videotaping in classrooms *without* a professional camera crew include the unwelcome intrusion of ambient noise and positioning the camera to see and hear children when they speak. Including the computer screen at the same time as the child's face (and voice) is on camera is difficult. Cameras break. Dual cameras are intrusive as is a camera crew. Since the software is audible, our attention focused on the child and his or her response together with accurate notes about which software was being used in a video segment. Software became so familiar to the research staff that they recognized the programs by their sounds.

VIII. Results and Discussion

The results discussed in this section were demonstrated and documented as patterns across children, classrooms, and sites. The ITLC benefited children's literacy behaviors and other behaviors as well in a number of ways to be discussed in this section. As this report is being written, the results from a second literacy project conducted by Macomb Projects staff are being tabulated. They support the findings of the present investigation. Each section of the ITLC – commercial literature-based software, graphics and story-making programs, and *HyperStudio*— produced differential changes in literacy behaviors.

Software and the ITLC Curriculum

Commercial Software. Commercial software programs, such as the Living Books series, had positive effects on social interaction as children listened to the stories, talked about the graphics, and asked questions about the characters in the stories. Children using the graphics and story-making programs tended to interact while drawing pictures, adding writing that ranged from 'invented typing' to their names and other children's names. Many children used *KidDesk* as a way to communicate with other children and adults as they 'wrote' notes, made calendars, and entered information into the address book.

Commercial software included Living Books, electronic stories with corresponding hard copy of the story. This software supported concepts of book, print, and story including *turning pages from left to right, reading from left to right and top to bottom, words have meaning,* and *stories have beginning, middle and end.* Children using this software tended to be more interactive with classmates, working in pairs or small groups, observing, pointing, making suggestions, and talking about the stories. When other types of commercial software were used, children labeled objects found in the stories, predicted sequences as they navigated through programs, and problem solved together as they worked their way through programs such as *Busytown.*

Tool Software. Graphic and writing software, such as *Kid Pix* and parts of *KidDesk*, were found to support emergent writing and drawing. Children used the graphics and writing programs

to print letters and words. When using *KidDesk*, children had the ability to communicate with others through notes, e-mail, and voice mail. Children accessed these options on a daily basis to 'type' strings of letters with occasional names and words in the middle of the letters or to hear messages from friends, teachers, and family members. Children using these programs were learning that print has meaning, that we can read what we write, and we communicate with letters and words. Children using graphic and writing software did not work in the small groups found during use of literature-based software. They usually worked in pairs or individually as they interacted with the programs.

HyperStudio. *HyperStudio* was effective in classrooms when the research staff was present and facilitated children in using the program. The *HyperStudio* component had a high degree of adult and child interaction as children authored stories, by making choices about what to draw, what to say about the story, how the picture should be animated, and what kind of sounds should be included. The ITLC *HyperStudio* component was more interesting to children as a process than as a product. Children enjoyed the process of creating the stack and often visited the computer center to view their work in progress. However, once the product was finished, many children were ready to move on to the next project or go back to using literature-based software or graphic programs. They would revisit their *HyperStudio* product occasionally.

During a classroom's second and perhaps third year, teachers' use of *HyperStudio* was mixed and depended on personal preferences, time, and enthusiasm. Teachers in Deer River, Barretville, and Medland continued its use while those in Fox Lake and Middlebrook did not.

HyperStudio supported children's literacy behaviors as they produced books. When using *HyperStudio,* children drew pictures that had meaning to them; dictated stories about the picture and/or the experience associated with the picture; and added buttons, sound, and video to enrich the story. Children were involved in the process as they listened and attended to the project and the adult who facilitated the project. Social interactions using *HyperStudio* tended to be one child and one adult working together to build the stack. Although all children had input into the process, children worked individually when using *HyperStudio* with another child occasionally observing the process.

HyperStudio was used to produce software that was unique to the activities and 'culture' of specific classrooms. Categories of stacks and examples included directions (*Paper Mâché* and *Carving a Pumpkin*); field trips (24 individual field trips and *A Trip to the Vet)*; class activities (*Winter, Puzzles, My Community, If I Lived to be 100*); storybooks (*What Do You Hear? and My Animal Book*); and sharing information (*All About Me, A Mouse in My Classroom, All About Us*). Other titles within the categories included *Three Bears in Preschool, 100 Day, Mouse Views, Friends Around the World, Five Little Pumpkins*, and *Classroom Stack.*

Three Bears in Preschool was developed after children read different versions of the three bears, and produced related stories and plays. The teacher scanned pictures of the bears, chairs, and beds into *HyperStudio*. Pictures and video were taken as children reenacted the story. These were added to the stack, and then children went back through the story and added text and accompanying storyline sounds.

Field Trips, was produced as an on-going project in a classroom where children made monthly field trips to a nearby town to swim, visit the library, visit a university, and play at a park. Photographs were taken of the places the children visited. When children came back to school, they added pictures of their own and text that related stories about the places they visited. The pictures consisted of a variety of products including water colors, computer-generated pictures, and drawings with markers and crayon. The pictures were added to the stack and children then dictated their stories and added text through 'typing' in text boxes. Each child has his or her own stack. At the end of the field trips, the 'books' were printed, bound and taken home as gifts to share with families.

All About Us: A Classroom Stack, was an informative stack that combined information about classroom activities, children, and families. The stack was a combination of pictures and video taken during classroom activities and pictures sent in by families to share information about each child's family and favorite activities and events at home. Text was added with sound to the pictures to further illustrate the stories. Some family members came into the classroom to add their own voices to the stacks.

HyperStudio stacks from other classrooms. A fourth section of the curriculum, *HyperStudio* stacks produced by other classrooms, did not support literacy opportunities. We believe that because *HyperStudio* functioned more successfully as a process, instead of a product, children were not particularly interested in interacting with stacks made in other classrooms. They did not use the computer when the *HyperStudio* stacks from other classrooms were offered. If not provided a different software choice, children would avoid the computer area and play in a different part of the room until other choices were offered. The stacks from other classrooms did not have enough sound or animation and did not meet the expectations children had of the interesting characteristics of computer software. Children would ask, *"What does it do?"* or *"What does it say?"* Although they accept linear stories in picture books, without animation or sound, the same children expect something more when they use a computer. Another factor is that because the programs were designed for the classroom that produced the program, it was 'classroom specific' and not of interest to children who had no part in developing it and who had different experiences.

Software Preferences

Children had definite software preferences. During the first year of the study, some children used the computer only when a particular type of software was available. Children who tended to enjoy writing and drawing activities in the book center also enjoyed using graphics software. Children who did not visit the computer when commercial literature-based software was the only choice, would make their first visit only after a drawing program was installed. For example, two girls stayed in the classroom writing center for most of their free time. They drew pictures and wrote stories, talking back and forth between themselves, paying little or no attention to other activities happening around them. They were not interested in the computer at all. Even during a Family Night when one of the fathers encouraged his daughter to use the computer, she responded that she didn't want to. The day *Kid Pix* was installed on the computer, the girls went to the writing center, as was their habit when they arrived. They were invited to watch other children drawing with the graphics program. After observing for a few minutes, they went to the sign-up sheet and signed up for a turn. After that first experience with graphic software, the girls became more interested in writing and drawing at the computer and often went to the computer center.

In another classroom, a child sometimes observed Living Books software, but did not interact with the computer. When a *HyperStudio* stack was authored with pictures of the child, activities in the classroom, and photographs of her family, she was often seen at the computer, clicking the mouse and verbalizing while clicking. The same child spent much of her free time walking in circles around the room clutching a torn and ragged book in her hands. When research staff members walked in the door, the girl grabbed their hands and pulled them toward the computer where she pointed at the pictures on the monitor.

Children who used ITLC programs had favorite pages and turned to the page, or entered options to go directly to the page where they then interacted, read, or sang songs from the page. Favorites were *Harry and the Haunted House* and *Just Me and My Mom*, programs that contained musical tunes. Children memorized the stories and songs. When they clicked on a paragraph or song, groups of children would recite or sing word for word along with the narrator's voice.

KidDesk was used by ITLC children across classrooms on a daily basis. They often spent several minutes engaged in desktop management with this program as they checked their calendar, sent e-mail, or chose a new desktop to display their program icons. The software gave them the freedom to make choices from their individual desktops, communicate with peers, and access their own desktop tools.

Another favorite was *Playskool Puzzles* where children could build their own puzzles or put puzzles together to see animation occur. Children worked cooperatively to put the puzzles together and then tried to guess what a puzzle would 'do' after it was completed.

Although *HyperStudio* was instigated by the research staff and did not originate with a child choice, children seemed to enjoy the process of authoring stories. The stacks, after completion, were printed, bound in book form, and read again by children in the reading center or shared with family members.

Second and third year classrooms implementing the ITLC without research staff direction used the same types of commercial story and graphics software used previously in the classroom. However, during the second year of participation, teachers used commercial story software more than graphics software, in a ratio of 6:1. Children who had been in the program during the previous year would sometimes ask for software they had used before, such as *Busytown* and *Harry and the Haunted House*. At the end of the year, one teacher who made a home visit learned that a child had been patiently waiting to use a program recently installed. Although he sat at the computer center and interacted with peers who were using the program, he himself had never controlled the mouse. He asked if he could have his turn to play when summer school started.

Children who were not engaged in the ITLC, but participated in Type III technology only classrooms did not express software preferences. Two of the classroom sites, Barretville and West Marlin, had limited titles. The West Marlin teacher reported that her children liked *McGee*, *Zoo Explorer*, and *Bailey's Book House*. This software was used the entire year. Teachers who routinely rotated books, activities, and themes, did not rotate software or add software related to classroom interests. In Barretville, the technology was older, and available software tended to require reading and keystrokes to operate. Children used software titled *ECH 1* and *ECH 2* and needed an adult to help them. In Medland, the teacher had many titles available. Hers was the only one of the three Type III classrooms that used *KidDesk*. However, she had every software program in her library installed and offered as a choice to the children. With 25 choices, children were overwhelmed and went to the same familiar titles repeatedly.

In ITLC classrooms, children did *not* prefer software that was located at Level 1 on the Interactivity Chart. This included Discis software and *Peanut Butter and Jelly*. These programs did not offer opportunities for children to interact with the graphics and words, nor did they offer a wide variety of selection choices. The pictures were static and the story was read to the children.

Some teachers had a difficult time with *HyperStudio*, not only because they needed to learn the program, but also because it took time to create the stacks. In the first year of the study, teachers in the Fox Lake and Middlebrook sites were encouraged to author *HyperStudio* stacks, with assistance and actual production from research staff, during a limited time frame (4-5 weeks) because part of the research design was to use the stacks in other classrooms for another section of the curriculum. More time should be taken to learn *HyperStudio*. In Years 2 and 3, these two sites did not follow through with the *HyperStudio* stacks. The teachers explained their lack of

follow through by saying creating the stacks was too difficult and too time consuming for them. Their learning period may have been too rushed and uncomfortable to gain real mastery.

Teachers in the other three classroom sites where the ITLC was implemented in the second and third years, continued to use *HyperStudio* to some degree, even after the completion of the study. Their use ranges from learning more about the software to effectively using it in the classroom to author stacks.

Implementing the ITLC

Effective conditions. The research team worked closely with teachers, not only to implement the ITLC, but also to integrate the ITLC into themes already existing in the curriculum, such as Community, Farm, Pets, and Spring. During the first year, the research staff were well acquainted with the software and provided workshop opportunities for teachers to evaluate and use software. Teachers demonstrated their knowledge during the following years when they evaluated and used software independently.

Effective classrooms offered children a literacy-rich environment which included materials for drawing, writing, making books, and reading—in addition to a variety of software. Print was found in many places in the classroom, including commercially-printed poems hung on the walls, stories dictated by children and hand written by teachers on poster paper, children's names, and labels for centers and various objects found in the classroom. Children in these classrooms repeatedly demonstrated a large number and variety of the literacy behaviors of concern to this study.

ITLC staff and teachers facilitated children at the computer by offering choices, modeling behaviors, and redirecting inappropriate behaviors. In Fox Lake, Deer River, and Barretville classrooms, where the ITLC was most effective, adults facilitated children's play, had techniques in place that enabled children to manage their own behaviors, and offered choices that were child-directed. Teachers facilitated 'sign-up' and turns with a sign-up book—a strategy that offered children the opportunity to manage their own turn-taking. Teachers positioned the computer at child-eye level, kept two or more chairs at the computer center, placed the software selections in the computer center for children to make choices, and changed software CD-ROMs when needed. They also changed centers on a regular basis to rotate new materials that matched themes and projects. Rotation included evaluating software and choosing software not only on the quality and interactivity level, but also on the interests and themes that were on-going in the classroom.

Although family involvement workshops were offered by research staff, teachers implemented their own family involvement activities related to the ITLC. Families participated as classroom volunteers, assisted in developing *HyperStudio* stacks by sending in photographs and visiting the classrooms to add their voices to the stacks, came to ITLC workshops, and served on technology committees to evaluate and purchase software for the classroom.

Ineffective Conditions. Conditions that were not effective in promoting the ITLC included directive behavior on the part of the teachers. Such behavior did not facilitate children's learning. Instead, children were told what do to and not allowed to make their own choices. Sometimes children were not allowed to use the computer as punishment for a negative behavior not associated with the computer (e.g., a child who had not listened and had misbehaved in the gym early that morning before school was not allowed to use the computer during class time). Sometimes children were allowed timed turns, from 5 to 15 minutes long; then the child was told that his or her turn was over and it was time for the next child. Despite the fact that children are seldom limited to 5 minutes when engaged in other preschool activities such as blocks, drawing, puzzles, or playhouse activities, Middlebrook continued the time limits for computer use. When questioned about this practice, the teacher said that because the technology benefited the children, she wanted all to have a turn. Her motives, while well-intentioned, resulted in children's negative behaviors.

The data showed that when teachers limited computer time and turns, children exhibited hostile behaviors and communicated less. The behavior was first observed in technology only classrooms where teachers forced turn taking and limited the time the children could use the computer. The same behaviors were later observed in an ITLC classroom when a teacher began implementing forced turn taking and time limits. Children forced to take short turns were concerned about not being able to accomplish their chosen activity. The computer area in that classroom changed from a place of social interaction and communication to an area of isolation and hostility. Children were protective of their time; did not want to share their space at the computer even with an on-looker; did not take time to communicate, share ideas with others, or call attention to an interesting picture or animation; and sometimes even pushed or shoved another child out of the way. These behaviors were in direct contrast to those observed prior to re-institution of time limits and in ITLC classrooms where children managed their own turns and times on the computer.

When ITLC teachers used ITLC on their own in the second and third years, in Fox Lake and Middlebrook, aides and sometimes teachers directed children's use of the computer and offered unnecessary help. For instance, they told children what to do in the program instead of offering the opportunity to explore and find out on their own. This was a common practice with student teachers and assistants. Sometimes the computers were not turned on nor were they offered as a choice to all children. Conditions viewed as ineffective were also found in classrooms that were not implementing the ITLC (Type III).

Off-computer Activities That Promote Literacy

Two off-computer activities that demonstrated literacy behaviors included sign-up sheets and books on which the Living Books software was based. Both practices were used to some degree

in all ITLC classrooms when the research staff were not involved; however, data showed that classrooms new to technology continued to use the sign-up book more consistently while classrooms that were not new to technology were not as consistent after the initial year of participation.

Sign-Up Sheet. One off-computer activity that effectively promoted emergent writing behaviors was use of a sign-up sheet. At the beginning of the first year, managing children's turns at the computer in the ITLC classrooms was difficult and confusing. Children gathered around the computer asking for turns, so staff wrote names down on a sheet, and before long children were 'writing' their own names on the paper. Names were in the form of scribbles and mock writing. Nevertheless, children recognized their own names and began to recognize others' marks.

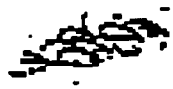
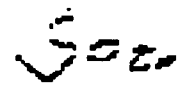
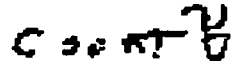
Researchers then bound several sheets of blank paper together into a sign-up booklet, dating each page. Children wrote their own names when they were ready for a turn. Clearly, children were writing for a purpose. Not only were they learning to write their own names, but they were also sequencing (who was next?), reading other children's names, understanding the concepts of print, and interacting socially as they discussed where their names were on the list in relation to others. Children began to move their names from the middle of the page up to the top and over to the left side as time went by.

The sign-up sheet was used in all ITLC classrooms. The sign-up sheet was kept near the computer, a new page for each day. A writing tool was placed nearby. The sign-up sheets also became a good problem solving tool and, as one teacher said, "*The children begin to understand if they sign up twice, they can have two turns on the computer.*" The children's names take on different forms as they move from scribbling to emergent letters to recognizable letters. Figure 6, on the following page shows examples of these changes.

The progression of handwriting samples was analyzed using dated sign-up sheets. Because sign up was not a requirement for using the computer, not all 255 children in the study had samples. Children were grouped according to the number of years they participated in the study. Samples were scored based on the amount of improvement from the beginning of participation to the end, using seven stages of emergent writing shown in Figure 7: scribbling, mock handwriting, mock letters, conventional letters, invented spelling, approximated spelling, and conventional spelling. Children who improved four, five, or six stages scored ++. Children who made a more moderate improvement of two or three stages over time scored +. Children who declined by one stage, made no change, or progressed one stage scored 0. Children who declined two or three stages scored - . No child declined more than three stages.

The change in handwriting supported the stages of emergent writing without the direct instruction used in many special education classrooms. Table 4 demonstrates that 51.5% of those participating two or more years advanced four to six stages and that 36.4% of the children made

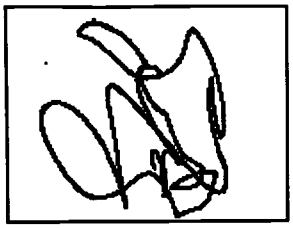
Figure 6. Samples of Children's Writing

Kyle	Kelsey	Courtney	Serena
 Date: 11/9/94	 Date: 11/14/94	 Date: 11/14/94	 Date: 11/9/94
 Date: 12/5/94	 Date: 1/26/95	 Date: 2/2/95	 Date: 12/5/94
 Date: 3/9/95	 Date: 3/7/95	 Date: 3/20/95	 Date: 2/7/95

gains of two to three stages, while only 12.1% made minimal or no gains. One might argue that the gains were the result of maturation; however, the fact that differences between ITLC and non-ITLC children in gains on the *ILA* increased with age points instead to the impact of the emergent literacy curriculum, integrated with technology.

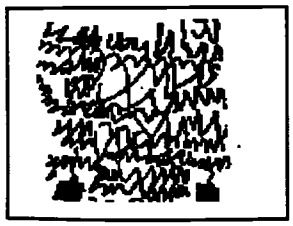
When children participated in the ITLC one year, 22.3% improved four to six stages while 25% of the children improved to three stages. It is important to note that 40% of the 55 children who made no gains began with stage 7 (conventional spelling), the ceiling, and could not make gains. A small percentage (7.3%) of the 55 children scoring 0 moved from approximated spellings

Figure 7. Stages of Children's Writing



Scribbling

Children's first exploration with writing can occur before the age of two. In this stage, random marks or "scribbles" often occur on a page with drawings.



Mock Handwriting

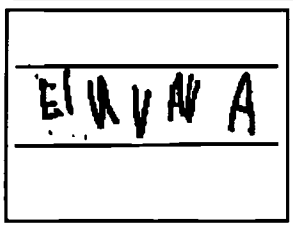
Children in this stage produce lines of wavy scribbles as they imitate adult cursive writing. Their writing often appears on a page with drawings. Children often return to this stage, even after they are capable of writing conventional letters.

Mock Letters

In this stage, children make letter-like shapes that resemble conventional alphabet letters. Mock letters appear spontaneously around children's drawings, as well as in their writing attempts.

Conventional Letters

As children's mock letters become more and more conventional, real letters of the alphabet begin to appear. The first letters written are typically the letters in the child's name. Children often create "strings" of letters across a page and "read" them as a sentence or series of sentences.

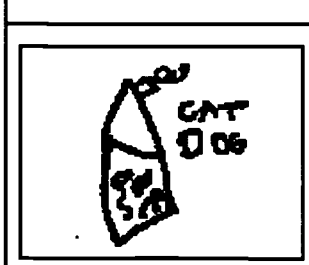


Invented Spelling

Once children are fairly comfortable in writing conventional letters, they begin to cluster letters together to make word forms. These words do not look or sound like "real" words. Children at this stage often ask, "What did I write?"

Approximated (Phonetic) Spellings

In this stage, children attempt to spell words based on their growing awareness of letters and sounds, and on their memory of words they have seen repeatedly. The words are generally written with capital letter or a combination of capital and lower-case letters. Children move from spelling words by writing the beginning consonant letter, to writing both the beginning and final letters, to writing words with a beginning, middle, and final letter-sound.



Conventional Spellings

Children's approximated spellings gradually become more and more conventional. The child's own name is usually written first, followed by words such as *mom, dad,* and *love.*

Table 4. Changes in Children's Handwriting Over Time

	Gain	%
1 Year	**++**	**25**
	+	**28**
	0	**55***
	-	**4**
2 Years**	++	14
	+	12
	0	3
	-	0

*22 of athe children that scored 0, started at stage 7 and ended at stage 7.
An additional 4 children scored 0 moving from stage 6 to stage 7.
** 5 of the children were in the study for three years.

to conventional spellings. Of the 112 children participating in the study for one year, only 3.6% declined by two or three stages.

One explanation for the decline is that children, like adults, write differently at different times, sometimes making their marks with painstaking care and at other times scribbling just to get a mark on the paper. Barclay (1990) points out that children often return to the mock handwriting stage even after they are capable of writing conventional letters. Perhaps children were more interested in putting marks down on the sign up sheet to hold their place than in making recognizable marks, or perhaps disabilities exerted increasing influence on children's abilities.

Two related studies demonstrated similar findings for sign-up sheets results (Godt, Hutinger, Robinson, & Schneider, 1998; Hutinger & Rippey, 1997). A literacy and technology demonstration project at Macomb Projects found that the practice of using the sign-up sheet (i.e., using a literacy behavior in an authentic situation) led to children becoming more skillful at both writing their names and also "reading" each others' names or marks. A collaborative research study conducted by Macomb Projects and Just Kids, a Long Island preschool, found similar data and provides an interesting check of children's progress in writing their signatures. Random pairs of children's signatures were taken from the computer sign-up sheets, with one signature gathered from the beginning of the year, another at the end. Fifteen of the signature pairs were then distributed to seven literacy experts. No information about dates was given. The experts were asked to identify which signature came from the beginning of the year and which came from the end. Experts accurately identified, on average, 75% of the final signatures. This was a clear sign of general recognition of improvement in the quality of the children's writing over the course of

the year, stimulated by the computer sign-up sheet, since there were few opportunities otherwise for writing in the classroom.

Living Books. The second off-computer activity that was effective in promoting literacy was use of the hard-copy of Living Books and books related to software themes. Children using the Living Books series would pull the hard copy of the book over to the computer area where they would then sit in pairs or small groups to look at, point to the pictures, read along, and make choices and comparisons between the book and the program. When children used the books on which the Living Books software is based, they were beginning to understand the relationship that the book has to the story, that pictures and books have meaning, that pages turn from the left to the right, the connection between turning the page on the screen and in the book to finding particular pages.

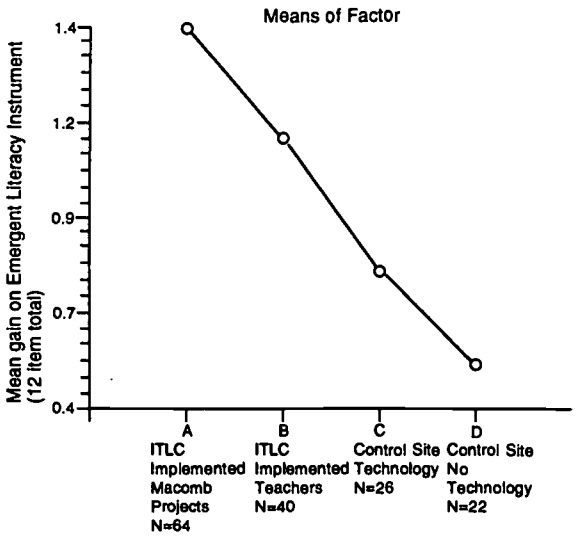
The Impact of the ITLC on Children

Differences Among Classroom Types

First Year Results on the *BIT* and the *ILA*. First year *BIT* and *ILA* scores were analyzed according to the Ganova multivariate statistical analysis program (Brecht & Woodward, 1987). Univariate analysis of variance with prior contrasts was performed on both the *BIT* and the *ILA* scores. No significant differences were found on either set of the mean pretest scores. At the beginning of Year 1 both the *BIT* and the *ILA* scores among all three classroom types were similar. However, at the end of the year, there were statistically significant differences and linear trends on the scores in favor of the children in the ITLC classrooms. There was a significant difference for the *ILA* between Types I and II ($p<.04$) and between Types II and III ($p<.03$). Differences were more pronounced for the *BIT*, with significant differences between Types I and III ($p<.006$) and between Types II and III ($p<.00001$). This finding suggested that perhaps the prior experience with computer technology of Type II's teacher and children had a positive effect on the ITLC, although we suspect that teaching style and classroom conditions played strong roles. Interestingly, the Type III teacher and children had just as much computer experience as found in Type II, but that factor alone did not contribute to increased literacy behavior in the children. Neither did it contribute to increased computer skills.

Second Year Results on the *BIT* and the *ILA*. Across ITLC sites in the second year, gains in literacy behaviors were seen in 3-, 4-, and 5-year olds. An Analysis of Variance testing for linear trends on the gains scores of the 12 item *ILA* measure is shown in Figure 8. The classrooms were grouped according to the following four categories: (1) technology plus the ITLC plus close supervision and assistance from the Macomb Projects research team, (2) technology plus the ITLC implemented by teachers, (3) technology alone, and (4) no technology. Although the distance between the classes is not equal, the order corresponds to the strength of the treatment. The highly significant linear trend means that the more powerful the application of technology and the

Figure 8. Analysis of Variance Testing for Linear Trends in Year 2



curriculum, the more powerful the results with children. Although the gains are not large, it should be remembered that the *ILA* is not a sensitive instrument and other benefits from the ITLC have been observed in the qualitative data which covers a longer time period and observation of behaviors children demonstrate in classrooms.

Second year results on the *BIT* were similar to first year results. Differences between the Type I and II classes and Type III classes were significant, $p<.001$. Over a two year period, 3-, 4-, and 5-year-old children in both the two ITLC conditions (N=114) and the non-ITLC implementation sites (N=48) showed gains on the *ILA* from the pretest to the post-test. However, the ITLC children showed greater increases on two thirds (66.7%) of the 12 items as compared to the non-ITLC children who made gains slightly better than the ITLC children by only three percentage points on one item ("points to pictures while reading") and equal to the ITLC group on "retells story in own words". The greatest gains in the ITLC group were shown on relatively sophisticated emergent literacy skills related to pretend "reading" with vocal inflection (40%, N=42 in the ITLC group, 25%, N=13 in the non-ITLC group), and sequencing stories in appropriate order (24%, in the ITLC group, 8% in the non-ITLC group). Interestingly, one third of 3-year-olds in ITLC sites turned book pages at the appropriate time (33%, N=8) but not one in the non-ITLC group did so. Fewer differences on ITLC items were found between ITLC 3-year-olds and non-ITLC children of the same age. However, differences separating the two groups were greater at four years of age, and even greater at age five, suggesting that the ITLC rather than maturation accounts for children's gains in literacy.

Third Year Results of the *BIT* and the *ILA*. At the end of the third year of the study, scores on both the *BIT* and *ILA* were analyzed using the Brecht Woodward Ganova 4 program of multivariate analysis of variance. The dependent variable was the difference between pre and post scores. Because of the theoretical and logical independence of the variables, each of the subtests of the *BIT* and *ILA* were considered as independent univariate variables. As a first step, all data were tested for normality. Where evidence of non-normality was determined, that fact was noted

but was not compensated for in the analysis. It often occurred when there was clearly no suggestion of significance. The meaning of significant skew and kurtosis is mentioned but not elaborated on. Subsequently, data in the cells of the analysis were tested for equality of variance. Where there were significant differences in variance among groups, Wald's Heteroscedastic ANOVA was used. Analysis of variance was then conducted for each of the variables and subsequently, planned comparisons were used to answer interesting questions suggested by the first analysis.

The independent subtests of the *BIT*, determined by factor analysis, were (A) Attending, (B) Resisting the computer, (C) Cause and Effect, (D) Expression, (E) Follows directions, (F) Independence, (G) Planning, (H) Calling attention to self in a positive way, (I) Calling attention to self in a negative way, (J) Peer interaction, (K), Cooperating with peers, and (L) Competing with peers.

Thirty-six paired t-tests were first performed on each of the three groups and 12 subtest variables to see if gains had been made. No significant gains were noted in any of the three comparison groups for variables B, I, and L. These three behaviors, resisting the computers, calling attention to self in a negative way, and competition at the computer were seldom observed. Pre-post differences for each child were usually 0 on those variables. Because of the lack of variability, these three items were excluded from further analysis.

Significant gains were made on variables A, C, F, G, H, and J for all three technology groups, Technology Only, ITLC, and ITLC + staff. Significant pre-post differences were found for two groups for variables E (follows directions) and K (cooperating with peers). An almost significant pre-post difference, ($p = .051$) was found for variable D (expression). The Technology Only group was the group of children who had technology but no ITLC; Group ITLC plus staff were classrooms during their first year presenting with the help and supervision of research staff. The ITLC group represented the same teachers who were in the ITLC plus staff group during a year of practice and instruction with research staff. These pre-post differences are shown in Table 5.

***BIT* Results.** On the first variable, *Attending*, there was no significant difference across all three groups. Perhaps the novelty or potency of the computer and software, regardless of how it is presented, affected all groups equally. The curriculum seemed to make no difference.

On the second variable tested, Cause and Effect, the mean gains were as follows:

Technology Only	0.35
ITLC	0.44
ITLC plus staff	0.73

The ANOVA was significant with $p<.05$. This would imply that the curriculum plus the research staff was significantly different from the technology only group. Further tests showed that

Table 5. Behavior Interaction Tool Pre-Post Scores and Probability for Independent Variables in ITLC with Staff, ITLC, and Technology Only Groups on the Behavior Interaction Tool

	ITLC with Staff			ITLC			Technology Only		
Variable	**Pre**	**Post**	**P<**	**Pre**	**Post**	**P<**	**Pre**	**Post**	**P<**
A	306	404	0.001	273	375	0.001	87	124	0.002
B	176	177	NS	240	240	NC	82	82	NC
C	99	164	0.001	177	221	0.001	46	58	0.016
D	97	95	NS	63	83	0.051	30	37	NS
E	98	158	0.001	210	269	0.001	42	49	NS
F	101	169	0.001	84	93	0.019	37	48	0.019
G	139	333	0.001	98	192	0.001	50	85	0.001
H	322	467	0.001	362	500	0.001	86	137	0.001
I	212	208	NS	231	237	NS	90	96	NS
J	200	308	0.001	191	248	0.001	47	78	0.005
K	276	467	0.001	340	489	0.001	67	96	NS
L	281	271	NS	330	329	NS	134	134	NC

curriculum only was not different from technology only and that technology plus staff was significantly different from curriculum only, $p<.05$.

For variable D, *Expression*, there was no significant difference among the scores of the three groups.

Variable E, *Following directions*, had highly significant skew and kurtosis of the data in all three cells. There was also a significant difference in variances so the Wald statistic was used. There was a significant difference among the scores of the three groups, $p<.05$. The mean differences were:

Technology Only	.026
ITLC	.590
ITLC plus staff	.674

The contrast for curriculum only and curriculum plus staff showed no significant differences. The average of those compared to technology only showed a significant difference of $p<.025$. In other words, both ITLC groups were similar in gains and did significantly better than the technology only group.

The mean differences for *Independence*, variable F, were significantly skewed and kurtotic for all three groups. Also, the variances were significantly different. Therefore, the Wald Heteroscedastic ANOVA was used. It showed an overall significant difference with $p<.001$. The mean differences were:

Technology Only	.324
ITLC	.143
ITLC plus staff	.864

From the overall significance it is apparent that the largest value is significantly different from the smallest. Thus, the presence of the staff was an advantage over the teachers presenting the curriculum by themselves, even though their data represents their second year of experience with the program. Observational data supported this finding. When teachers and program assistants implemented the ITLC in the second year, they were more directive with children and more restrictive in allowing children access to software. A planned contrast comparing technology only with curriculum only showed no significant difference, p=.092.

Planning, variable G, showed a significant skew for all variables and significant differences in variance. Therefore, the Wald Heteroscedastic ANOVA was used again. The overall difference in means was significant, p<.01. The mean differences were:

Technology Only	0.3224
ITLC	0.940
ITLC plus staff	2.180

Use of the curriculum with assistance from the research staff was clearly superior to use of technology without the curriculum. The planned contrast between curriculum only and technology only was also significant, with p=.002. The difference, then, was due to the ITLC, whether or not the staff was involved.

Variable H, *Calling attention to self in a positive way*, showed mean gains which were not significantly different. They were 1.5,1.4, and 1.6 respectively. We believe that this means that children called attention to themselves more as the year went by, but this tendency was not related to the way the program was presented. Perhaps, as children matured and grew more accustomed to classroom procedures, they had more to say about themselves in general.

Variable J, *Peer interaction*, had all groups showing normality of the mean differences for variances. The variances, however, were significantly different which again called for use of the Wald Heteroscedastic ANOVA. This test showed an overall significant difference among groups with p=.01. The mean gains were:

Technology Only	0.912
ITLC	0.570
ITLC plus staff	1.213

A sequence of planned contrasts showed significant difference between the curriculum plus staff and both technology only and curriculum only, indicating a greater amount of positive social, peer-to-peer interaction among children when the research staff implemented the ITLC.

In summary, it appears that the presence of the research staff was crucial to obtain positive results. When teachers were left on their own, even with support, the results were significantly superior to technology only groups in the cases of planning and following directions. Thus, the ITLC, when presented with fidelity and with supervision, is effective and produces significantly superior results on most of the *BIT* variables. However, a year of training teachers does not seem to be sufficient to obtain the high quality results obtained with closer technical support.

ILA Results

The *ILA* was divided into four subtest of four items each, *Book Handling, Pictures, Text,* and *Story.* In contrast to the *BIT*, an additional "no technology" comparison group was possible. As in the analysis of *BIT,* the first step was to do paired t tests between pre and post results. No significant gains were noted for the Text variable. However, there were significant gains on *Book Handling* for the ITLC group. In addition, there were significant gains on the *Picture* variable for that group and the curriculum plus staff group. There were significant gains on the *Story* variable for all but the no technology group. Thus, some technology was better than none in all instances. See Table 6.

Table 6. Pre-Post Scores and Probability for Independent Variables in ITLC with Staff, ITLC, Technology Only, and No Technology Groups on the Informal Literacy Assessment.

	ITLC with Staff			ITLC			Tech Only			No Tech		
Variable	**Pre**	**Post**	**P<**	**Pre**	**Post**	**P<**	**Pre**	**Post**	**P<**	**Pre**	**Post**	**P<**
A	144	153	NS	172	184	0.010	58	66	NS	61	63	NS
B	100	130	0.001	130	159	0.001	37	40	NS	37	47	NS
C	11	21	NS	19	28	NS	5	0	NS	4	5	NS
D	67	139	0.001	100	181	0.001	17	45	0.001	35	35	NC

The next step was to determine whether there were significant differences in the gains made by the different groups. The *Text* variable was excluded because there were no significant gains in any of the groups for that variable. The method of analysis was the same as that used for the *BIT* results. There were no significant differences among all groups for the first two variables, *Book Handling* and *Pictures.* There were significant differences among groups for the fourth variable, *Story,* p=.004. Indeed, the second weakest group, technology only, is significantly different from no technology on this variable, p=.011. The mean gains are as follows:

No Technology	0.000
Technology Only	0.718
ITLC	0.827
ITLC plus staff	0.837

The data on *Story* indicate that any kind of technology is helpful in increasing the concepts; however, adding the ITLC increase the effect somewhat.

The Impact of the ITLC on Emergent Literacy Variables

Oral Communication

Oral communication was divided into four categories: appropriate vocabulary, self-talk/self-direction, conversations with others, and labeling. Differences among ITLC classrooms and non-ITLC classrooms were found across categories.

Appropriate Vocabulary. Children involved in the ITLC used appropriate vocabulary when referring to computer components and navigating through software programs. When children used the ITLC software programs, they discussed what was occurring in the program and what they would like to do. They used describing words as they pointed to graphics and talked about what would happen when something was clicked on or asked another child to push on 'that.' Children made choices about programs to use. They talked to each other and helped each other change CD-ROMs and navigate through software programs. Children discussed the sign-up book and whose turn was next. They talked to adults as adults facilitated children's play and discussed software. These types of oral communication were documented in all ITLC classrooms, both those with research staff and with teachers only.

Oral communication at the computer in Type III classrooms was seldom observed. Adults were often present at the computer, questioning, directing, and facilitating. Children seldom worked in pairs or small groups. Oral communication was not promoted at the technology center. Since the children exhibited less language, a limited vocabulary resulted.

Self-talk/self direction. Children involved in the ITLC exhibited behaviors denoting metacognition. As they worked, children talked to themselves about what they were doing in the program. They directed their own planning as they made decisions. Children also repeated what the computer 'said' as they heard different and new words.

Some similar behaviors in technology only classrooms were documented as children verbally planned out what they would do and used exclamations that demonstrated pride in their accomplishment as they made a discovery or accomplished a task. Although children in classrooms without technology talked to themselves to show pride in an accomplishment or acknowledgment of an activity, they did not use self-talk to plan what they were going to do or to talk themselves through a process.

Conversations. Children involved in the ITLC when the research staff initiated the literacy curriculum carried on conversations about the software as they discussed characters, actions taking place, and the story line, or what would happen when a character or object was clicked. Children conversed with other children and held child-directed conversations with adults (who

facilitated instead of directed). Discussions about the software ensued as adults asked questions about what was happening in the program and what a child thought the software would do next. Many times children were observed conversing with each other about how to go about doing something as a child helped a peer work his/her way through a difficult navigation activity. For example, Paula was using *KidPix Studio* to draw a picture. When she finished, she said, *"I want to get out of this."* Ed proceeded to help her by telling her to go to FILE in the menu bar and then QUIT. Ed not only talked her through the quitting process, he also showed her by pointing to the screen.

If peer help did not work, children sought assistance from an adult. Perhaps they needed assistance going back a page to see the dancing bugs again, or perhaps the problem was more difficult as the child found that he/she had chosen the Spanish rather than the English option in a Living Book. Interactions were similar with literature-based software when the research staff did not initiate the ITLC, although conversations were directed less often toward children and more often toward teachers who helped children with the programs.

When using graphics programs, children carried on similar types of conversation in ITLC classrooms with and without research staff present as they received help from peers or talked about the tools in the program. Again children requested help from adults as they tried to find a tool that would make a different design or the letter tool that would let them type on a page. Children using graphics programs also discussed what they were doing or a choice that needed made. During the first year of the study, two children were observed working side by side at the computer, one child maneuvering the mouse while another child took control of the keyboard. The child with the keyboard would point at the screen and tell his friend to click "there." After the other child clicked the cursor in place, the child typed until he ran out of room on the right. They would then repeat the sequence until the whole page was filled with text.

Different kinds of conversations took place when children used *HyperStudio* in their own classrooms. Conversation were usually between adults and children about what would be recorded on the microphone as the adult asked the child what he/she planned to say. They practiced the phrase or sentence and then the child recorded the message. Conversations when building stacks were about letters and names of objects as children labeled parts of their pictures. Discussions centered on words that the child would use then type or on words the child wanted the adult to place on the 'card.' Adults and children also talked about the contents of the stack.

Children in Type III (technology only) classrooms had different kinds of conversations when working with technology. Conversations were generally related to directions when children asked adults questions and received a response.

In Type IV classrooms, children were observed during play talking to peers about what they were doing as they played and about what they were making during activities. They interacted

during social situations, such as lunch or snack time, and when they requested help from a friend. Children in the ITLC classrooms had similar conversations to those of children in Group IV during center time as they worked with manipulatives and interacted in housekeeping.

Labeling. Children labeled objects in software programs when interacting in the ITLC. Children labeled while working with other children, but also received adult help as adults asked questions about objects or talked with children about the software program. Children involved in the ITLC without research staff continued to label objects in the software programs, but adults were not observed facilitating the process.

When using graphics programs, children labeled graphics and stamps found in the programs. This was also true when children used *HyperStudio*, but children had a wider variety of graphics to label as they labeled people found in the pictures including themselves, names of people, and characters found in stacks. When children labeled objects in the *HyperStudio* programs, they worked with other children and with adults.

Labeling was also observed when children worked with *HyperStudio* stacks from other classrooms as they again labeled graphics found in the stacks. This pattern was present in ITLC classrooms only when research staff was present because the research staff showed an interest in the stacks, sat next to the children, asked questions, made comments, and shared information about the stacks. Teachers tended not to spend the time needed to interact with the children and the stacks or to spark children's interest in the stacks made by other classrooms.

Although labeling took place in classrooms that did not use the ITLC, it was often under the direction of an adult who initiated the labeling interaction and expected children to respond. Children also labeled objects outside of computer experiences during center time when adults asked questions about objects.

Children in classrooms where technology was not used showed no significant patterns in labeling, although classrooms involved in the ITLC demonstrated significant trends while using books outside of the ITLC.

Changes in Storytelling

When parents and family members were interviewed and answered questionnaires, they indicated that they saw changes in their children when 'reading' books. After participating in ITLC, children wanted to tell the story and take a greater part in the nightly reading activity. The coding for storytelling was split into four parts; 'describing characters', 'retelling a story', 'articulating key concepts', and 'dictating stories.' No significant patterns were found across software groups when children described characters in stories. This behavior was seldom documented.

When children retold a story, activities related to this element were not sufficient to constitute a pattern when the research staff facilitated the ITLC. Although they retold major events, they did

not include a beginning, middle, and end to their stories, as required by our definitions. Sometimes retelling stories does not follow a textual story, but is related to telling stories from pictures in the book. More significant patterns were documented in the second year of ITLC use when literature-based software and the related hard copy books led to children directing their own style of storytelling, although it did not meet our definition criteria. In ITLC classrooms with research staff, children read books, initiated retelling stories from books during free play, and read books with adults in activities away from the computer, while in classrooms involved in the ITLC for two years, children reread stories through the pictures in the books.

In technology only classrooms, children did not demonstrate retelling stories while using the computer and related software, but they did initiate their own retelling of parts of stories outside of the computer during free play and other times during the day.

Children in classrooms that did not use technology looked at books during group time and during reading time under adult direction. Children also retold stories from books.

Key concepts. Children involved in the ITLC when the research staff facilitated the technology articulated key concepts of stories in commercial literature-based software and elements of stories produced in *HyperStudio* when working in the ITLC, but this was not observed in the Type II classrooms in their second year or in the Type III classrooms. It is interesting to note that children in ITLC plus staff classrooms did not retell a story from books at the computer, but in the second year of working with the ITLC articulated key concepts. Children in classrooms that did not use technology did not show any significant patterns related to articulating key concepts.

Dictation. The definition for 'dictating a story' was that a single child dictated a story that had a beginning, a middle, and an end. Dictating stories did not show a representation of significant patterns in any group: however, in one Type IV classroom, children dictated parts of stories in journals under adult direction. This was done once a month when children drew a picture and dictated the story to the teacher.

Recognizing Letters

Children involved in the ITLC showed significant patterns in recognizing letters in both commercial literature-based software and graphic software. This included letters in menu words. Examples would be 'T' for text, 'Q' for Quit, 'F' for file, 'P' for print and similar navigation words. Other navigation words contained letters that children recognized as they started, worked through or finished activities. When children opened programs, they viewed key words like *English, Spanish, Read to Me, Play with Me,* and *Options*. Children quickly learned which letters to click to navigate through the sequence to end where they wanted to be. Similar results were found in the following years as children worked in the ITLC.

In Type III classrooms when children used programs, they matched letters and numbers to activate programs. Children used programs that required key strokes to activate the sequence in the program. For example, they looked at a number on the screen and then looked at the keyboard to find a match for that number, then pressed the number to make something happen.

While all of the letter recognition activities observed in classrooms that used technology were related to processes and activities in which children were engaged, in classrooms that did not use technology children recognized letters that were related to their name. Although this activity was observed in ITLC classroom, the ITLC children recognized letters in a greater number of contexts.

Identifies and/or reads words. Identifying and reading words were part of activities in ITLC classrooms. Children recognized their own names and other names on the sign up sheets in all sections of the curriculum including using their own *HyperStudio* programs. Children recognized software program words such as *Quit*, *Yes* and *No*. In interviews, teachers mentioned words children recognized, including *Exit*, a word not commonly used in the classroom but found in the school hallways. *Exit* and *Stop* are commonly used words in software programs. Children who used *KidDesk* identified and read classmates' names when communicating through notes and e-mail. Common occurrences included children asking teachers to spell names, or children finding class name cards, bringing them back to the computer and typing a letter, note, or e-mail to another child, addressing it with that child's name.

In Type III classrooms, no significant patterns emerged, although in Type IV classrooms, children recognized their own and classmates' names. This was comparable to the ITLC classrooms where children recognized names outside of the computer environment in drawings and objects that were identified with names such as coats and backpacks.

Identifies environmental print. Along with recognizing letters and identifying and or reading words, children identified environmental print (including logos) in software programs. Children recognized icons that represented programs on *KidDesk* and then reached for the CD-ROM containing the software, placed the CD-ROM in the drive, and clicked on the icon to play the software program. When using *HyperStudio*, children identified the tools found in the program. The pencil, paintbrush, and eraser are commonly found icons. In graphics programs, children again identified menu icons related to the tools; pencil, stamps, eraser, and paint tool icon. Children also recognized the *Print* icon and clicked on it to print out the picture.

A teacher, during the third year of using the ITLC, described a child who worked through a program, *Big Job*, navigated a driving experience, and received a certificate. Before he was done, he had found the printer icon and asked to print his certificate. Children using *KidDesk* commonly printed notes to take home to friends and family members. In one ITLC classroom, a little girl placed a *cake* icon on the calendar on *KidDesk*. She clicked the *Print* icon, turned to the classroom teacher said her grandma's birthday was this month and she was printing the calendar for her.

Children in Type III classrooms also recognized icons related to computer programs, but did not match the icons to the CD-ROMs. They also found and used the *Print* and tool icons to navigate through programs.

Children in Type IV classrooms did not demonstrate a significant pattern related to identifying environmental print.

Drawing

Although emergent writing tends to appear first in children's drawings, this was not the case for ITLC children who used software to draw using free drawing tools, stamps, stamp letters, and text. When the ITLC was used without the research staff facilitating, adults tended to direct graphic programs to derive specified products. In the first year of the ITLC curriculum when research staff were present, when children used *HyperStudio* programs, drawings were also adult directed both when using the tools in the program to create and when drawing pictures for scanning. Children engaged in free drawing activities using the tools, coloring and erasing images in developing *HyperStudio* stacks.

Many of the drawings created by children in classrooms where the ITLC was not used were not created on the computer and not related to computer programs. Many of the activities called "art" by a teacher were craft and ditto pages. The few computer related drawings were created at an adult's direction and related to a topic or theme.

Classrooms that did not use technology drew images during free play, but also drew at adult direction for journal activities or for a craft-related activity. Craft activities, such as making paper chains or bunnies out of circles and ovals, were more prevalent than drawing.

Changes in Emergent Writing

Children exhibited emerging writing behaviors in the ITLC when using the sign up book at the computer center. Handwriting samples are shown in Figure 6. In other classroom activities, ITLC children used emergent writing in dramatic play when playing school and library at home and school. Invented spelling was documented in ITLC classrooms. This was observed and documented in sign-up books.

Children in technology only classrooms used emergent writing when writing their name and during dramatic play. Children in Type IV classrooms did not demonstrate any significant patterns, although children in one of the Type IV classrooms dictated in journals. While the children drew pictures and had the opportunity to write, they were not encouraged to write what they said. We could not differentiate between their drawings and writing. Children involved in the ITLC showed the same significant patterns when printing their names in activities outside the ITLC, while children involved for more than 1 year were printing more words than their names.

'Reading' a Book

The ITLC effected positive changes in children's 'reading' a book. This does not mean that preschoolers read each word as do literate elementary school children. Instead, it means that as children look at the pages of a book and turn them, from front to back, they 'read' the pictures, remember the content of a particular page or group of pages, then repeat the story aloud or to themselves. More sophisticated behaviors emerged when children used Living Books software.

Children involved in the ITLC looked at and 'read' books. They pointed at pictures and carried on conversations about the graphics on the pages of electronic story books. 'Reading' often occurred with small groups of children. The groups ranged from pairs to seven or more children. Many children were interacting with the story on the computer while holding the book, pointing to pictures, reading along, and turning the pages of a related hard copy of the book such as *Harry and the Haunted House*. It was common to see three children at the computer; one child operating the mouse, another child holding the book and turning the pages, while another child directed the actions. This behavior carried over to graphics software. Children looked for a related hard copy of a book and, instead, found the software manual tucked into the CD-ROM case. Children would pull out the manual and proceed to 'read.' Manual use was not commonly observed as classrooms carried the ITLC over into the second or third year.

Children continued to 'read' books when using *HyperStudio* both in their classrooms and from other classrooms. When interacting within their own *HyperStudio* stacks, activities were often adult directed with children occasionally choosing, on their own, to interact with the stacks. Children were reading and turning the pages in stacks while attending to words and names found on the 'cards' in the stacks. 'Cards' without words and sound held little fascination for some children, so they flipped past a 'card' without words and sound. When asked why he skipped over those pages, one boy said, *"they don't talk, they are boring."*

When children used *HyperStudio* stacks made in other classrooms with the research staff, the activity was child initiated. Some children liked to look at individual children's stacks that were developed in their own classroom—they knew their peers and enjoyed looking at and asking questions about the stacks—while a few preferred stacks developed in other classrooms. Children interacted with the software clicking on 'hot spots,' watching, and observing as discussed earlier in the section on *HyperStudio* effects.

Looking at and 'reading' books during computer use was not commonly documented in Type III classrooms. Many of the reading activities took place when adults conducted group events during circle time and story time. When computer programs were involved, adults were involved even if the activity was child initiated.

In classrooms where technology was not used, children read books during a required reading time, during other adult-chosen times, and during adult interactions in reading activities. Children

also read books during free time when they requested adults to read with them. It is interesting to note that many of the book activities took place only when the activities were adult-initiated, while in ITLC classrooms when children were not interacting with technology, children looked at books in the book area with other children, listened to books on tape, and 'read' alone in the book area. The children in the ITLC classroom also read with adults during circle time and adults read to children during free time.

Problem Solving

When children used commercial literature-based software, different behaviors were observed when ITLC staff were facilitating than when teachers were facilitating. Children made choices, asked for help and helped others when involved in problem solving activities when ITLC staff were present. When teachers facilitated the ITLC, children were more involved in solving problems through navigating through programs and changing CD-ROMs. In technology only classrooms, children were involved in the process of maneuvering the software. *HyperStudio* activities, when research staff facilitated the ITLC, included solving problems within the programs, making choices, and asking for adult help when needed. When children used graphics programs, children helped others with the software, solved problems when moving through the software, and made choices.

Problem solving in Group III classrooms was evident when children maneuvered through software. Children were not actively involved in solving problems in classrooms where technology was not present, perhaps due to the high degree of adult decision making and teacher-directed activities.

Predict Sequence and Outcomes

Some form of prediction was observed with all children involved with technology, although children involved with the ITLC were observed predicting and sequencing in a greater variety of situations. When using commercial literature-based software, children predicted the outcome of activities and understood and demonstrated the sequence to get to an activity, while children in classrooms where the ITLC had been present for more than 1 year predicted names using the first letters of the names and predicted computer-related words using the first letter of words related to computer programs, such as *Quit, File,* and *Menu.* When using graphic programs, children predicted what would happen when choosing graphic tools, navigating through the programs and the menu to save, print and open programs. Children showed knowledge of outcomes when navigating through programs; for example, an aide said, *"Click here."* The child responded, *"It'll take me out of the program."* The aide said, *"Click here."* The child clicked on the spot and exited the program. The aide responded, *"Oh, it took you out of the program."*

When using *HyperStudio*, children predicted sequence and outcomes when navigating through programs and predicted the outcome of buttons when using their own stacks. When using

stacks created in other classrooms, children demonstrated predicting sequence and outcomes when they printed. They knew what would happen when they clicked on an object. For example, a child said, *"Watch this. The house is going to sneeze."*

In ITLC classrooms during the first year, observations indicate children predicted the story line in books and understood the sequence of turning pages in books. In classrooms that used the ITLC in the second year, children were observed predicting the names and letters found in printed materials.

In Group III classrooms children demonstrated predicting abilities when sequencing the computer keys or the steps needed to activate or navigate a program. Children in classrooms where technology was not present were not observed interacting in activities that facilitated predicting sequence and outcomes.

Ability to Make Judgments

Children made different judgments depending on the behavioral requirements of the software. When using commercial literature-based software, children made judgments about what was happening or going to happen, about when their turn was done and whose turn was next. Children were able to make judgments about the mechanics of the program. This included determining what action to take to get to the next page or activity in a program, what icon to click, and what CD-ROM to choose to activate a particular program. Classrooms involved with the ITLC more than 1 year not only made judgments about the program and within the program, but showed strong trends in the navigation process; how to get from one place to the next.

When they used graphic programs, children continued to make judgments regarding whose turn it was and when their turn was over. Choices and judgments were made when choosing software and the activities within the software. This included tool and color choices. We found strong trends in judgments when children worked through the mechanics of the program and decided on the steps needed to print. These patterns continued in the Group II classrooms that used the ITLC for more than one year.

When children used *HyperStudio* to author their own stacks, they made process choices. Such choices included decisions on what photographs to incorporate into a stack, what sounds to add to the drawings or photographs, and what kind of animation might occur within the stack. For example, Marty pointed to the paper towel holder in the photograph, indicating to the adult facilitator that he wanted the towel holder to do something. When the adult asked Marty, *"What do you want the towel holder to do?"* Marty said quietly, *"Paper towels coming out."* As the adult finished creating the button while talking to Marty about the animation process, Marty said he wanted it to make a noise. When asked, *"What kind of noise,"* Marty responded that it should sound like tearing paper. Using paper towels from the classroom towel holder, Marty experimented with crumpling and tearing paper towels until he was satisfied with the noise. Then

he, with the adult's help, recorded the sounds he had chosen. When the process was finished, Marty clicked the button to watch the paper towel holder animation and listen to the sound. He smiled.

Children also made judgments about buttons including placement, size, and the look of the button (visible or invisible). Children made judgments about what tool and colors to use. Unlike the commercial and graphic and tool software where many of the interactions were children working alone or with other children, *HyperStudio* tended to involve an adult and child or children working together to author the stack. In classrooms where children used *HyperStudio* programs authored by others, children made judgments about what to click on or what stack to look at.

In classrooms that did not utilize the ITLC, but did use technology, children tended to make judgments about whether or not to use the computer (e.g., if they were told it was their turn to use the computer, they could decline). They were also able to decide what software to use. Decision making activities in the classroom as a whole tended to be computer related. Children directed the software decisions and judgments, although at times adults assisted children's decision making about what to do in the software program.

In classrooms that did not use technology, children made judgments about their play activities. Children made judgments while interacting with other children and with adults about what they were going to do in their play activities.

Listening

The ITLC provided many more opportunities for engaged listening and attending than the comparison classrooms. Children involved in literature-based software not only listened to and responded to directions from children and adults, they also listened to directions, music, and stories given in the software. Listening behavior was found consistently across classrooms initially involved in the ITLC as well as classrooms that continued with the ITLC during the second and third years.

When using graphic programs, children listened to other children as they helped direct peers through the program. They also listened to directions from other children and adults; however, in classrooms involved with the ITLC for more than 1 year, when children used graphic programs they tended to listen to adults rather than other children.

In classrooms that created and used their own *HyperStudio* software, children listened to adult directions about buttons and tools. Sometimes they listened to other children as choices were made. In classrooms that used *HyperStudio* programs made by others, children listened to and responded to both the computer and to adults.

In classrooms where technology, but not the ITLC, was used, listening behaviors tended to occur when a child was working with an adult at the computer. The child listened to and responded to computer cues.

Children listened to adults direct the storytelling activities and read books in classrooms where technology was not used. However, similar types of listening behaviors were observed in ITLC classrooms when the computer was not used.

Attending

Active involvement in books and software and responsiveness to adults' and other children's requests or directions were categorized as attending behaviors. In ITLC classrooms when children were not involved in the ITLC activities, it was common to find them actively involved with books. The children attended to software programs, adult directions, and help and direction from other children. They also paid attention to letters and words. This pattern continued as classrooms used the ITLC over 2 or 3 years.

Similar attending occurred during *HyperStudio* use. When children authored and used their own *HyperStudio* stacks, they attended to the program and to adult directions as they used and produced buttons and opened stacks. When *HyperStudio* stacks made by other classrooms were used, sometimes children worked alone while attending to the software. When an adult facilitated the child at the computer, children also attended to the adult and responded to the adult questions. An adult's presence was often necessary to keep a child's interest in *HyperStudio* stacks produced in other classrooms. If the adult did not converse with the child about the stack, the child would choose or ask for another program or leave the computer area.

Children in technology only classrooms attended to the computer programs, but also spent a large amount of time attending to teacher directions. In classrooms that did not use technology, we did not find a strong trend in attending behaviors.

Off-computer Literacy Behaviors

Groups I and II both showed a significant pattern in literacy behaviors outside ITLC activities. In Group I, children read books, retelling partial stories with children and adults. Parents were able to see changes in children using books and retelling stories. One mother said her child was now using books for the purpose they were intended instead of as roads for his car.

In Types I, II, and IV classrooms children conversed in centers and had classroom conversations. In non-ITLC activities, Type I and II classrooms showed significant patterns in looking at or 'reading' books. Children looked at books in the book area, read at home to other children and read with adults; adults read to children during circle, and children read with adults in the book area. In Group II classrooms, adults read to children; children read to children; children listened to books on tape, and they read alone in the book center. Groups I and II both had significant trends in using labels while using books outside the ITLC.

In other classroom activities, significant patterns included 'prints letters/words' in Groups I and II, including writing names in the first year. During the second and third years, children wrote words. Group I writing samples showed invented spelling. The sign-up books showed progress across stages. Groups I and II showed significant patterns related to use of emergent writing in playing, school, library, dramatic play, home and school. Group II demonstrated emergent writing in dramatic play, writing at home, and in writing names.

Outside of ITLC activities, children predicted story line, read books, and turned pages in an appropriate manner in classrooms that used in the ITLC for a year. In classrooms that used the ITLC for more than a year, children were observed interacting (reading and writing) letters and names. Moreover, children in the Type III and IV classrooms did not engage in these activities during the observations.

Use of Related Literacy Materials

In ITLC classrooms, literacy materials used by children included hard book copies of the Living Books software and sign-up sheets for a turn at the computer. Related materials also included manipulatives (puppets, puzzles, teacher-made materials) that focused on classroom themes and software. In ITLC classrooms children interacted with books when not involved with computer activities.

No significant trends regarding the use of literacy materials were observed in classrooms that used technology only. In classrooms that did not use technology, related literacy materials tended to be flip charts, flannel boards, and recipe boards. All activities were teacher directed and the teacher handled the materials.

Social Interaction

Use of the ITLC effected positive changes in social interaction among children. Children did not view using a computer as an isolated activity. They shared, took turns, and cooperated with one another as long as their time was not limited and when computer time was not used as a reinforcer or withdrawn as a punishment.

Sharing and turn-taking. When using graphic and commercial software, children involved in the ITLC shared ideas and helped others navigate through software. The children cooperated at the computer while using the mouse and worked together through discussions and actions. Children took turns through use of the sign-up sheet and held discussions about whose turn it was. When children used *HyperStudio* in their own classrooms, they continued to take turns willingly.

In technology classrooms that did not use the ITLC, sharing and taking turns at the computer was not documented as a common occurrence. In classrooms that did not use technology, children shared toys during free play.

Social interaction and communication among children. When children used literature-based software in the ITLC, social interaction and communication took place as children helped peers facilitate turn taking discussions, gave directions when using software, and discussed software characteristics. Children talked about the hard copy of electronic stories as they looked at the software. It was common to see two or three children at the computer—one child controlling the mouse, one child holding the hard copy of the book, and a third child pointing from the book to the software page on the computer screen as discussions took place about the pictures and actions. These behaviors occurred across ITLC classrooms. Children often observed other children's actions at the computer.

Similar behaviors were exhibited when children used ITLC graphic programs. They talked about navigating from one place to another within the software. They helped each other use the program by making suggestions, sharing ideas and discussing what was taking place. Again these practices occurred across all the ITLC groups.

Children often observed the actions taking place at the computer even if they were not using it themselves. For example, in the first year of the study, a child who spent most of her day in the writing center never ventured further during freeplay, and never used the computer. When graphics software was introduced, she left her place in the writing center and came over to the computer where she asked if she could sign up. When it was her turn, another child informed her of the fact—the sign-up sheet at work! She sat down, used the mouse, and made choices in *Kid Pix*. Keep in mind that this child had not used the computer before. After drawing a picture, she asked to save it by typing her name and then asked to print the picture. All of the things she asked to do were behaviors that we had observed her classmates doing every day in the classroom. This child had watched her peers over time, knew the basic procedure that the children used at the computer, and successfully completed her project—observational learning at work!

When children authored their own *HyperStudio* stacks, they tended not to interact socially with other children but with adults, since the authoring process required interaction between adults and single children as the process was completed. Children conversed about the content of the stack, taking turns, and the processes necessary to complete the stack. On the occasions when children were documented using other classes' *HyperStudio* programs, the users talked about the content of the stack and what the software might do.

In classrooms that did not use the ITLC, children interacted with each other during center time, read books, and played in the dramatic play centers. At the computer, the oral communication observed in the ITLC classrooms was not present. Children tended to interact at the computer by pointing to objects and graphics on the monitor and communicating through gestures rather than speech. Hostile behaviors were documented at the computer as children pushed and sometimes hit.

In classrooms that did not use technology, children were most often observed interacting in games, putting puzzles together, interacting during dramatic play and free time.

During the first year of ITLC, families reported that children interacted at home when playing with siblings, reading books, and writing. In classrooms outside of the ITLC, children were observed directing others.

Social interaction among children and adults. In classrooms that used the ITLC during the first year with research staff facilitating, children had conversations with adults about their turns and the sign-up sheet. Interactions were child initiated with assistance given by the adult. Adults were observed asking open-ended questions at the computer center. Children initiated discussions about the software, discussed letters and words, and expressed pride in their accomplishments. In classrooms that used the ITLC in the next year, directed by the teacher, adults facilitated discussions about the software with children. In one classroom, a software program, *ArtSpace*, was chosen by two children. An adult facilitated opening the program and navigating through the program. Children opened a picture featuring the American west with a buffalo painting. Conversation about the picture occurred with the teacher posing questions about the picture.

However, when the adult was a student teacher whose computer literacy was woefully lacking, one of the boys searched for the buffalo painting again, ignoring her intent to exit the program (she didn't know how) and her commandeering the mouse. The child spent eight minutes or more searching, enduring the efforts of the student teacher to dissuade him, and, when she left, finally found the picture to show to his friend. They looked at the picture, listened to the music, and listened to the gallery viewer's comments about the painting.

When using graphic programs, children asked for and received help when they asked questions about software and hardware. Adults also facilitated the drawing process. When carrying the ITLC over to the next year, teachers tended to initiate interactions as they helped children with the software programs.

When children worked with their own *HyperStudio* programs, they often directed (told others what to do). Adults initiated conversations and interactions with children when giving directions for buttons and helping with computer.

Adults facilitated children's need for help in navigating the *HyperStudio* programs produced by other classrooms. Adults often questioned children about the program in order to entice them to stay involved in the software program. This occurred when research staff initiated the use of stacks produced by other classrooms but was not observed when teachers took over the program.

In technology only classrooms, the pattern of adult interactions with children was to give directions, help children, and rotate children on and off the computer. Without sign-up sheets, children had no means of regulating computer use independently. Adults in classrooms with

technology only often spent time reading books to the children each day but did not discuss the story elements of software.

In classrooms that did not use technology, children were often involved with adults in group activities, making craft projects, writing journals, and interacting in circle activities. Adults seldom interacted with children during free play. They did not facilitate or enter in children's play. The adults were involved only in directive activities such as the journal, crafts, and circle activities.

Differences Among Children who Participate More than One Year

The nature of the early childhood programs' cross-age grouping allowed the opportunity to collect data on children over time. Out of the 255 participants, 30 children participated for 2 years, and 6 children participated in the ITLC curriculum classrooms for 3 years. Differences in children were documented over 1 year, 2 years, and 3 years.

The majority of children participating for 1 year did not have prior experience with computers. The children did not know how to manipulate the mouse, change CD-ROMs, or navigate through the software. Over the year, the children exhibited increased computer knowledge, worked independently at the computer, and used the appropriate terminology while directing themselves, helping others, and giving advice.

In all but one of the ITLC classrooms, reading centers were available. Children's visits to the reading center, while not a common occurrence in the beginning of the ITLC, increased over time. Children visited the reading center more frequently, choosing to interact with books during their free choice time. The longer children were involved in the study, the more they tended to interact with books. Children's interaction and involvement with interactive electronic books increased over time. During the end of the second year of his involvement in the ITLC classroom, one boy picked up the book *Just Grandma and Me* and read the story. Another child in his second year began to find books in the library that were related to topics introduced in the software to share at home.

At the beginning of the study in the ITLC classrooms, children explored pictures in stories, but by the second and third year, they had progressed to interacting with the story from beginning to end. During this time, children changed their focus from pictures to words. Many children were beginning to recognize that print had meaning. Behaviors progressed from clicking randomly on words to clicking the words in sequence, indicating that children recognized that the words told a story. During explorations with a Living Book, one of the study children progressed from clicking on pictures to clicking on the words of the story from left to right and top to bottom. The child studied the computer monitor intently and listened to words as she clicked. After several weeks of reading the story, she began to click the words in order as they appeared in the sentence.

Labeling objects in stories, both commercial electronic stories and *HyperStudio* stacks, was a common occurrence for children who were just beginning with the ITLC. As the children

progressed to the end of the first year and into the second and third years, they began to describe and discuss characters and objects in the commercial stories and offer richer descriptions when authoring their own *HyperStudio* stacks.

Findings show changes in communication when children were involved in the study over time. Communications changed from self-talk, labeling, and one-word descriptions to discussions between two (or more) children. Children shared ideas in discussions about story and characters, procedures in graphic software, and navigation through software. A young boy who joined the study during the second and third year, did not communicate in the beginning. His first words, "Power Rangers" were said at the computer when he was looking at his shoes in a *HyperStudio* stack. By the end of his second year, his sentences were complete, and he was able to share ideas about the stories with which he interacted. The child could also help peers who needed help.

A documented difference for children participating in the study for 1 year, 2 years, and 3 years occurred in the handwriting samples. Children started at different stages, usually drawing or scribbling. As time progressed, the children wrote their names with some or all of the letters.

Listening and attending to the computer changed over time in both length and quality. At the beginning, children's time on task was short and sporadic. Children's interaction with software programs tended to be for short times. The longer children were involved in the ITLC, the longer they attended to programs. The children took time to explore software in depth and shared discoveries with other children and adults. Often, this same behavior is documented during other classroom activities. For example, Hal entered our study during the second year. He did not have an interest in anything in the classroom. He cried most of the time and would not participate. However, the computer was the one center where he did show an interest. At first, he only watched from across the room. As time went on, Hal began to sit with other children and watch. Then Hal moved to signing up and viewing the Living Books on his own. By the beginning of his second year, Hal could recite lines word for word from a Living Book, *Just Grandma and Me*.

Experiences at the computer center filtered into other areas of the room. Computer use gave children knowledge beyond their everyday experiences. Children gathered their new experiences and began to make sense of new knowledge as they participated in other activities and shared with other children. Fox example, a child exploring *Just Me and My Dad* enjoyed the camp-out with Little Critter and Dad. The child, along with friends, created a camp site in the dramatic play area where they recreated scenes from the electronic story by collecting props from the classroom to use in their adventure and building a "pretend" fire and tent.

Teachers and Classroom Staff

Teacher and Staff Reports of Changes in Children's Literacy Behaviors over Time

When children participated in an ITLC activity for a year, teachers and classroom staff reported a change in language, social interaction, and ability to attend. Comments included,

> *The computer provides a lot of good language models when reading the stories for the children. The children are also using a lot of language while at the computer. Also, we see that the children are typing their messages and printing them out at the computer. These are their own stories or poems and sometimes the children keep them and sometimes give them to a friend. The children are also sending messages over the telephone (on* KidDesk*) for another friend, so they are using language in that way.*
>
> *Many, many of the boys and girls who do not really care to use the book center because it is not lively enough or because they have attention difficulties love the Living Books...they like to watch it read to them; they click on individual words to hear them spoken. They take the actual storybook and follow along as the computer reads. They turn the pages with the computer.*
>
> *They are making books of several pages in length, illustrating, and dictating words to it. It is a story that makes sense and has sequence. They like to hook the pages together so it turns the pages like the computer. They have drawn arrows at the bottoms of the pages like the computer.*
>
> *As the computer highlights the words on the page, [the children] are hearing the stories at the same time they are seeing the page. They are learning left to right progression of the words and reading top to bottom. The children are understanding that the words they hear are printed on the screen.*

In the classrooms where the ITLC was in effect for more than a year, teachers found that children were more cooperative and helpful. In a classroom that had two computers, instead of isolating children, the two machines offered children the opportunity to share their skills and facilitate children at the computer next to them as they helped each other take out a CD-ROM or navigate through programs. Teachers found that children socialized more at the computer than in some areas of the room and found more verbalization in this area than in many other centers. Children used different words when they used the computers in the ITLC. Teachers reported

differences in speech patterns at the computer as children used words related to technology and the software programs. Children also used books differently. For example, one teacher said that before the computer came in, the children really did not go to the book center as much as they did after the ITLC was in use. Children were also writing more as they accessed e-mail in *KidDesk*, printed out calendars for family members, and 'typed' notes to peers and family members.

The Skills Teachers and Staff Need to Implement the ITLC

Internal motivation to implement the ITLC is an overriding necessary condition. Beyond that, teachers and staff must possess knowledge and skills related to emerging literacy and creating a conducive environment to foster literacy behaviors in young children. They need to be able to use computer equipment and software with emergent literacy activities. Knowing how to evaluate and install children's software programs as well as where to buy and how to receive support from companies is important. Since *KidDesk*, a desktop environment that fosters independence in young children, was used so successfully in the curriculum, teachers need to understand the importance of the program and how to install and set it up so *KidDesk* meets individual children's needs in the classroom. If individualized software is to be produced by classrooms, teachers should understand how to use *HyperStudio*. Acquiring the skills and knowledge to troubleshoot basic technical problems is necessary. This may range from a loose printer or mouse cable to the steps to take if a CD-ROM is not working.

During the study, the most effective path for the acquisition of these skills included workshops and ongoing curricular and technical support. Members of the research staff also pointed out children's behaviors to teachers, so they could focus on emergent literacy and technology benefits for the children. Then teachers and staff understood and were able to document the children's behaviors. Not only did this foster awareness, it also influenced teachers and staff to share positive benefits with others including families, other teachers, therapists and administrative personnel. Training teachers to use adult productivity applications not only benefited correspondence between families and the classroom, but also increased the teachers' and classroom staffs' skills and comfort level with the technology. Adult use included producing newsletters, calendars, databases, progress reports, and letters.

Effective Teaching Strategies

Effective strategies to carry out the ITLC include the adults in a classroom taking the role of a facilitator when children use the ITLC. Adults need to offer children choices, model their own enjoyment of the computer and its use, and redirect any negative behavior. Setting up the environment with *KidDesk* and appropriate software choices that integrate classroom activities into the computer center is necessary in carrying out the ITLC. Ensuring that the environment is literacy rich and stocked with books, writing tools, song charts, puppets and flannel boards extends the technology activities into other areas and allows children to take what they are doing

and learning at the computer center and extend the learning into other areas. After using *My First Incredible Amazing Dictionary* with a teacher-made 'hard copy,' a child printed out and bound her own dictionary of animals. The materials to complete the task were located in the writing center of the classroom and were 'everyday' materials that could be used by the children.

Ensuring that the technology is 'chosen' by the children and not advocated by the adult as a tool to be used by all children is important when administering the ITLC. In the first year of the research study, an adult in a classroom directed a child to sign up for the computer and continued to ensure that the child signed up. Videotape footage, field notes and observations of the incident showed fear in the child's face and continuing observations over many days showed that the child was reluctant to use the computer. It was not until the next year and this adult was gone that the child become an avid user of the computer center.

On the other hand, many observations, videotapes, and field notes have documented that when children are offered software choices and activities that are of interest, they use the technology. An example is a child whose interest was fire, fire trucks, and fire fighters. The technology had been implemented in the classroom for some time before *Busytown* was introduced. An activity in the program includes a simulation of preparing for a fire by dressing and climbing onto the fire truck before driving down roads to the fire and putting the fire out. The child was playing in the nearby play center with a fire hose when he heard the word 'fire' come from the computer center. The child jumped up, yelling "Fire," and raced for the computer center where he observed the fire activity.

Using a 'sign-up' book and facilitating its use was an important strategy. The 'sign-up' book was found to reduce stress in the technology center and offer children control over the process. Children understood that by drawing or signing their name, they would have a turn at the computer. Another important strategy was providing new activities that integrated a classroom project or theme with the ITLC and ensuring that the technology was tied in. Teachers evaluated and changed the software but still allowed a variety of software to be used.

Encouraging family involvement with the ITLC was accomplished through awareness activities including newsletters and notes, workshops focusing on knowing software and more adult applications, inviting family members into the classroom to facilitate the technology environment, or sharing the technology during open house.

Inviting input from and sharing progress with the speech therapists secured their participation and cooperation as speech therapists noted changes in communication behaviors. As a result of including speech therapists in the information feedback loop, they noticed that the computer gave children a reason to communicate. Speech therapists discovered the computer as a useful tool for language development and, as a result, requested that the schools provide a computer for speech therapy. Four of the six schools provided the computers.

Ineffective strategies for using the ITLC included adults using the computer themselves during center time instead of offering children the choice to use it, adults directing instead of facilitating at the technology center, and adults not providing the computer as a choice. Rotating children's turns without considering the child's engaged learning and activities that were taking place led to negative results (e.g., children not sharing, children not communicating with each other, children pushing). Offering unnecessary help without allowing children the opportunity to explore and solve their own problems also produced negative results. Often when student teachers arrived in classrooms, they had a negative impact on the technology center as they directed children's actions and took over at the computer center without allowing children the opportunity to share their own knowledge and skills with the new adult.

Problems Classroom Teachers and Staff Encounter

Classroom teachers and staff overcame various problems as they integrated computers and implemented the ITLC. Some problems were specific to the technology. For example, classrooms had technical difficulties with printing. The majority of the schools in the study did not have a Technology Coordinator on staff, and teachers were on their own until the research staff could come out to work with them. If a school district did have a "technology expert" on staff, that person was not inclined to recognize the importance of technology in the lower grades and most often stayed in the higher grades.

Teachers needed to be comfortable enough with the technology to work their way through the programs, and often teachers needed to learn "the little things" to solve their problems. For instance, one teacher brought a CD-ROM back to the ITLC staff, telling us that it was broken. When the CD-ROM was examined, it had something sticky on it. After cleaning, the CD-ROM worked fine. At times more difficult technical problems occurred.

Not every attempt to tackle technology met with failure. One teacher successfully upgraded memory for her computer. With the ITLC staff help, she ordered the memory. The teacher asked the computer person in the high school to help her, but was told she would need to wait awhile. So, a research staff member talked the teacher through the process and she installed the memory. When the computer person finally came to install the memory, the teacher said that she had already put it in. The computer person responded that the ITLC staff had put it in for her, and the teacher smiled and said, "*No, I put the memory in.*" Not only had the teacher upgraded her own computer, but she was proud of her accomplishment.

Other problems were specific to the ITLC. Taking turns was difficult for young children. This problem was recognized in the first few days of installing the computers. The "sign-up" sheet was incorporated into the ITLC soon after computers were placed into the classroom. The sign-up sheet, in terms of management issues, was a success and yielded rewards as children managed

their own turns and wrote their names for a purpose. In addition the change over time as children worked through the concepts of print was observed

HyperStudio required an adult's presence and skill to author the stacks. The program also takes time to learn. Once teachers have mastered the process, using the program becomes easier, but teachers still expressed concern over the time required to plan and create *HyperStudio* stacks. When teachers understood the potential of the classroom-specific stacks, and were able to understand and use *HyperStudio,* some continued on their own to use the program to some degree.

Differences in Teaching Styles Among Staff

Results from the *Teacher Learning Style Checklist* revealed that on the self evaluation, each teacher reported a high score, ranging from 93 - 99%. These results are consistent with self-evaluation trends noted by Hook and Rosenshine (1979), whose research showed that teachers tend to evaluate themselves higher than independent external evaluators rate them.

Four Research Associates used the *Teacher Learning Style Checklist* to evaluate the teachers. An average of those scores resulted in lower percentages compared to teachers' self-evaluation scores. All sites with the exception of Medland scored an average of 79-92%. Mean 'yes' scores, from highest to lowest, were Fox Lake, 92%; Deer River, 86%; Barretville, 80%; Johnstown, 80%; Middlebrook, 79%; and Medland, 42%. The scores agreed with the rank order achived among observations and videotape segments taken in the classroom. Observations and videotape segments taken during the third year of the study continued to document the consistency of the scores from the second year. Observations and videotape segments from Medland taken in Year 3 revealed the classroom, staff, and family interactions improved. Documentation of this classroom after the study reveals a marked improvement in the classroom as Medland continues to implement the ITLC.

Differences between teachers and staff in Type I and II classrooms. The differences between teachers who were new to technology and those who were experienced technology users was not a significant variable. The first year of the study, the research staff were responsible for implementing the ITLC in both Types I and II classrooms. Not until the second year did Type II teachers implement the ITLC on their own.

Initially, as classroom teachers and staff moved into their second year and positioned themselves to manage the ITLC, they had a difficult time making it work. An increase in directive adult behaviors at the computer center was documented. The adults changed the CD-ROMs for children who were new to the classrooms. This situation was different from prior opportunities presented by the research staff when all children had the opportunity to manage the center and change CD-ROMs as needed. The directive behavior continued in the Middlebrook classroom until the teacher was comfortable with the new children's use of technology.

Positive changes included teachers' use of technology to produce newsletters for families and family involvement activities that included technology. Classrooms continued to use the computer to publish books. Moreover, books were present and used in the technology center.

Classrooms purchased and used their own equipment, such as complete computer systems (CPU, monitor, and printer). Six teachers went further than this and purchased peripherals such as digital cameras and scanners to allow children's pictures and activities to be incorporated into *HyperStudio* applications.

Families

Across ITLC classrooms, families reported changes in children that corresponded to behaviors observed in the classrooms. Positive changes in literacy behaviors were reported over the 3 year period.

Families participated in interviews and surveys all 3 years. Additional information was collected in field notes and informal interviews as family members visited classrooms and workshops. Families reported that they saw children looking at, reading, and interacting with books more than before. Children were also retelling stories instead of only listening passively to family members read the story. Children who had not previously asked to be read to asked family members to read to them. Families reported that children were paying more attention to letters, words and names as well as to pictures.

Families were very satisfied with the ITLC in the children's classroom, remarking "great learning experience," and "good for future." Two responses from parent interviews included,

> *Yes, I do think the computer in the room has helped Mary. She can pick out a computer in any book or picture now. She definitely has more of an interest in having a book read to her. She has more interaction with the book and pictures now when we read a book. It has helped her with the reaction-action type things and her verbalization with things she recognizes. She is listening more attentively to books.*

> *The computer has been a real help for Ned. Watching him on the computer has given us an idea of where his strengths are that we can pursue, as well as skills that are lacking. It has shown me a whole different side of him.*

Changes in the Literacy Environment of the Home

Families changed the technology environment of the home. Fifteen families purchased computers and/or either increased the amount of time their children could use the computer or began allowing their children to use the computer that was already in the home. In one of the first family interviews, a mother admitted she had not thought of allowing her young son, diagnosed with Pervasive Developmental Disability (autism), to use the home computer. Later, after

observing the effects of the ITLC in the classroom and realizing the benefits from the use of the technology at school, the parents purchased software and encouraged their son to use the home computer.

Other families bought more appropriate software for use at home, asking for and receiving guidance from the teacher when buying software that aligned with what was being used in the classroom. Families and teachers reported that they saw book buying behaviors changing as families bought books that were related to the software program. One ITLC teacher reported,

> *A mother just sent in four Richard Scary books because of [her child's interest in]* Busytown. *The children have learned the names of the characters and [their interest] is carrying over into the books parents buy. The children are making connections [from the software] to characters in other books. This mom knew how much we like* Busytown, *and she sent us the books to borrow for a while. The parents hear about what we are doing from their kids, and that is helping them make choices in books that they're buying instead of buying books based on the latest movie...*

Family Participation in the ITLC

Families were involved in the ITLC in different ways. All were aware of the study through initial letters that accompanied the permission forms each year explaining the ITLC and research project. They were kept up-to-date with information printed in ongoing newsletters from the classroom teachers and staff. Teachers talked about the ITLC at open house meetings and during progress reports. Families expressed a willingness to be involved in the ITLC and the research project as they filled out questionnaires, surveys, and answered questions in informal and formal interviews. All families were invited into the classrooms to use technology and ITLC with children. Some participated in those activities while other families came to afternoon and evening workshops where they recorded messages over voice mail and left e-mail for their children, learned more about the software that was used in the ITLC, or gained technology skills as they learned how to use a mouse or a word processing program.

Family members discussed software programs with their children when children came home at the end of the day and shared a story about a program that they had worked on that day or a picture that had been created in a graphics program. In Fox Lake, parents joined a group that evaluated software prior to be purchased for the classroom.

IX. Impact

Products

Print, video, and software materials, described in the following sections, were developed during the three year's of the Early Childhood Interactive Technology Literacy Research Project.

Printed Materials. At the end of the project, the activities used in the study were combined with literacy activities used in a sister project, a model demonstration project, to produce a collaborative curriculum, *eMERGing Literacy and Technology: Working Together*, to demonstrate how literacy and technology can work together in the curriculum for all children in early childhood classrooms. *eMERGing Literacy and Technology: Working Together* contains 8 chapters plus references, resources, and appendices. Chapter titles include an Overview, Designing the Environment, Selecting Software, Curriculum Activities with Commercial Software, Curriculum Activities with Tool and Graphic Software, Curriculum Activities with *HyperStudio*, Customized Activities and Adaptations, and Family Involvement. The Overview offers a brief review of research and emergent literacy along with the effectiveness of the Curriculum. Designing the Environment discusses a literacy-rich environment and managing the computer center. Selecting Software demonstrates five levels of interactivity found in software and software found in the five levels. Curriculum Activities found in chapters Four, Five, and Six offers ideas to integrate over 35 appropriate titles into an early childhood program. Chapter Six also contains an overview of *HyperStudio* along with a mini-tutorial. Chapter Seven describes switch and touch tablet input to adapt programs for children. The last chapter discusses levels of family involvement, workshops, and resources for families. The appendices found in the curriculum share forms and materials for use with the curriculum.

Using developmentally appropriate practices, along with technology, *eMERGing Literacy and Technology: Working Together* provides suggestions for ways to incorporate activities into the curriculum. The curriculum's discussion of software titles offers basic information about software programs including publisher, system requirements, and a description of the software. Materials needed for the activity are listed as well as any preparation activities that need to take place. Information and ideas on introducing the software and extending the activity are shared for each curriculum activity as well as suggested questions that facilitators may ask children while using the computer. Also included are integration ideas for art, blocks/manipulatives, construction, cooking/snacks, dramatic play, group/individual experiences, music and movement, outdoor play/motor, science/math, literacy links, related books, poems, stories, related software, extensions beyond the classroom, and family connections.

Training videos for families and staff. *Once Upon a Time...Computers and Early Literacy Development* features the story of computers and early literacy development in preschool classrooms that were part of the study and in classrooms that participated in the related model demonstration project. The video reveals the use of the interactive technology literacy curriculum to promote emergent literacy for children with mild to severe disabilities. After an overview of results found in classrooms implementing the curriculum, video segments from interviews of teachers and children actively involved in classrooms using technology are used to illustrate the

effectiveness of the curriculum. Input devices and strategies for choosing software are shared as five interactive software levels are described. Curriculum application ideas are shared and also can be found in the accompanying guide.

Software. Software based on thematic units from the early childhood classrooms involved in the study were created using *HyperStudio.* The children contributed to the stacks through pictures, artwork, video, and sounds. Pictures ranged from photographs taken by children, pictures scanned from books, to clip art found in *HyperStudio.* Artwork included drawings done with markers to watercolor pictures or a combination of media. Video clips included in stacks emphasized projects that children were working on, from artwork to a production of The Three Bears. Recorded sounds ranged from children's voices to sounds found in the program. *HyperStudio* stacks covered various projects including field trips, making paper mâché, puzzles, and retelling of favorite children's stories. The software stacks have been collected and are available to share with others.

Availability. The Interactive Technology Literacy Curriculum products are available from Macomb Projects, 27 Horrabin Hall, 1 University Circle, Western Illinois University, Macomb, Illinois, 61455. Order a catalog by calling 309-/298-1634. The Web site address is www.mprojects.wiu.edu.

Dissemination Activities

Project information has been and continues to be disseminated in several ways. Information about this Project appears in Macomb Projects' World Wide Web home page (www.mprojects.wiu.edu). Findings were discussed regularly with the Expert Panel and the Type I and II site teams, which included teachers, administrators, and therapists.

As shown below, information dissemination efforts included articles in local newspapers (Galesburg, Jacksonville, and Macomb), *ACTTive Technology*, and the satellite broadcast (Apples Magazine). For example, regionally, an article about the Project's work in the Avon, Illinois, preschool classroom appeared in the Galesburg, Illinois, newspaper in February, 1996. The research staff disseminated information at local, state and national conferences throughout the three years of the project. National conferences included TAM and Closing the Gap. Presentations related to the study were made in 1995, 1996, and 1997 at the Early Childhood Technology Conference in Macomb, Illinois.

Participating staff, families, and administrators were continually updated during staff and family workshops. In addition, families received current information through weekly and monthly newsletters, while administrators were informed of results during yearly presentations on the campus of Western Illinois University. Other dissemination activities included presentations in Early Childhood classes at Western Illinois University, participation in local AEYC events, and poster sessions at area conferences.

Presentations. The following presentations were given, based on information gathered during the course of the Project.

"Emergent Reading, Writing, and Technology." Florida Assistive Technology Impact Conference, Orlando, FL: October 18, 1997

"The Effects of Technology on Emergent Literacy in Children with Mild to Moderate Disabilities." TAM/CEC Conference, San Jose, CA: February 1997.

"Empowering Children, Families, and Teachers with Technology." CAEYC Conference, Chicago IL: January 1997.

"Early Findings: Emergent Literacy and Technology." Activating Children Through Technology, Macomb, IL: March 1997.

"HyperStudio, An Affordable Alternative." Closing the Gap, Minneapolis, MN: October, 1997.

"HyperStudio: Building Blocks." Two Rivers Professional Development, Avon, IL: February, 1997.

"Early Childhood Emergent Literacy Technology Research Project." What's New In Assistive Technology for Young Children," Jacksonville, IL: March, 1997.

"Empowering Children, Teachers, and Families with Technology." IASCD Conference, Chicago, IL: February, 1997.

Showcasing "The Emergent Literacy Technology Project." Sharing a Vision, Springfield, IL: October, 1997.

"Once Upon a Time: Computers and Emerging Literacy." APPLES Magazine, an Illinois State Board of Education production, Western Illinois University, College of Education, Macomb IL: December 1996.

Publications. Articles about the Project appeared in the Winter 1995 and the Fall 1995 issues of *ACTTive Technology.* Curriculum activities from *eMERGing Literacy and Technology: Working Together* appeared in *ACTTive Technology* issues in Fall 1996, Spring 1997, Summer 1997, Fall 1997, and Winter 1998. References to the Project were included in an article, "Computer Adaptations for Young Children with Disabilities: Recurring Themes" by Hutinger (1996) and in a book chapter by Hutinger and Johanson (in press).

Implications of Findings

Engaged, meaningful learning and collaboration involves challenging real-life tasks and technology as a tool for learning, communication, and collaboration. Today's workplaces and tomorrow's communities need people who can think critically and strategically to solve problems. Gatz and Meeham (1998) point out that today's children must learn in a rapidly changing environment, that their knowledge must be built from numerous sources and different perspectives, and that children must understand systems in diverse contexts. They go on to say

these circumstances are incompatible with instruction that assumes the teacher is the information giver and the student a passive recipient.

Engaged learning is woven through the ITLC model. The model is set in an environment where children take charge and are self-regulated. The children are constantly learning while deriving excitement from the learning process. They collaborate with others as they interact with the technology and solve problems. The ITLC approach blends technology into thematic or project-related units, each unit related to meaningful situations. Teachers facilitate learning as they guide children and offer rich learning environments, experiences, and activities. Children are offered opportunities to explore with technology in a non-threatening environment while building on their knowledge of the world. In some situations, the ITLC offers children the role of "teacher" as they guide peers through a new learning environment or extend new ideas learned with technology out to the world around them. Families and community members are part of this learning process as the children move the learning outside of the classroom.

The study's findings provide powerful implications for curricular change and/or additions in programs for young children with disabilities. The progress children with disabilities made in behaviors related to emergent literacy, an area that has received little attention in special education, with the exception of a few projects in this country, holds great promise for benefits to children. The addition of computers, interactive software, and the ITLC have the potential to be of great interest to decision makers at all levels, as well as program staff and families. Computer technology, while not a panacea, provides access to emergent literacy knowledge and skills.

Positive changes resulted from three sections of the ITLC; interactive commercial software, tool function software (primarily graphics), and *HyperStudio* within classrooms. The increases in positive social interaction and communication among children as they participated in the ITLC with a degree of independence teachers hope for and parents long to see would be enough to adopt the ITLC, without the positive gains in literacy. The positive results of the use of two management tools, sign-up sheets and *KidDesk* were unexpected, but can be applied to a variety of situations.

X. Future Activities

Macomb Projects received a 3-year Outreach grant from the U.S. Department of Education's Early Education Program for Children with Disabilities which began October 1, 1997. LitTECH Outreach[5] will train others throughout the country to use the ITLC model. The original Types I and II classrooms are continuation and demonstration sites for the model while the remaining classrooms are continuing replication sites. Data will continue to be collected by staff in the sites and will be analyzed by the Outreach staff.

[5]PR #HO24D70020

The findings of the present study have been replicated in a model demonstration project. A series of articles about various aspects of the project will be written and submitted for publication to a variety of journals, particularly those that reach classroom teachers. Selected articles will be published on the Macomb Projects' web site.

The ITLC curriculum was published by Macomb Projects and was first available at the Macomb Projects booth at *Closing the Gap* in October 1997, in Minneapolis. Plans include organizing the ITLC curriculum activities and other content into an interactive curriculum on CD-ROM where teachers can find literacy curriculum materials to meet their needs through different searches.

XI. Assurance Statement

A full copy of this report has been sent to the ERIC Clearinghouse on Handicapped and Gifted Children. Copies of the title page and abstract were sent to NEC*TAS, the National Clearinghouse for Professionals in Special Education, the National Information Center for Children and Youth with Disabilities, the Technical Assistance for Parent Programs Project, the National Diffusion Network, the Child and Adolescent Service System Program, the Northeast Regional Resource Center, the MidSouth Regional Resource Center, the South Atlantic Regional Resource Center, the Great Lakes Area Regional Resource Center, the Mountain Plains Regional Resource Center, the Western Regional Resource Center, and the Federal Regional Resource Center.

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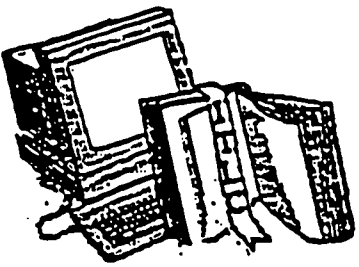
Appendix A: Research Instruments



Informal Literacy Assessment

Child's Name _____

Child's Age _____

Directions: Observe child as he/she reads a familiar book to you, the researcher. Place check under appropriate column.

Yes	No		
___	___	1.	Child holds book in an upright position.
___	___	2.	Child follows text from left to right.
___	___	3.	Child points to pictures while "reading".
___	___	4.	Child points to text while "reading".
___	___	5.	Child turns page at appropriate time.
___	___	6.	Child labels pictures in the text.
___	___	7.	Child "reads" with vocal inflections.
___	___	8.	Child identifies self-selected words in the text.
___	___	9.	Child points to words as researcher reads text.
___	___	10.	Child actually reads the text.
___	___	11.	Child retells the story in own words.
___	___	12.	Child sequences story in appropriate order.

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EMERGENT LITERACY BEHAVIOR INTERACTION TOOL (B.I.T.)

Kate Harshbarger Patricia Hutinger Peggy Struck

Revised, August 27, 1996

Child _____ Room ____ Observer(s) _____

Date(s) _____ Teacher(s) Consulted _____

Method of communication (Circle one): Speaking Signing Communication device Other _____

Instructions: Below, you will find a series of descriptions of behaviors. BITS will be taken at the beginning and end of the school year. The duration of the BIT data recording will be about two weeks. The rater will observe videotapes taken during the designated weeks. Not all classes need to be observed during the same two weeks. The observer also will talk to the child's teacher(s). The observer will check all behaviors observed during that week. Only one check is needed during the observation period. Children will be observed under three conditions: 1) with one or more child, 2) alone, and 3) with an adult. These three situations should not be contrived (arranged) beyond the following. If the child refuses to work with an adult at the computer, do not force the situation. Mark the apropriate blanks.

1.0.00 CHILD/ADULT

1.1.00 Obtains Attention of Adult in Socially Acceptable Ways

_____1.1.1 Shows pride in work
_____1.1.2 Asks for assistance from adult
_____1.1.3 Explains the problem ("this doesn't work")
_____1.1.4 Follows rules or directions (If this behavior is not observed by the end of the week, give the child a direction and see if s/he does it.)
_____1.1.5 Communicates processes to adult
_____1.1.6 Expresses enthusiasm physically to adult (hugging, smiling, clapping)
_____1.1.7 Expresses enthusiasm verbally to adult
_____1.1.8 Selects an activity independently
_____1.1.9 Does an activity independently

1.2.00 Obtains Attention of Adult in Unacceptable Ways (See 1.1.00)

_____1.2.1 Withdraws physically from adult
_____1.2.2 Expresses hostility physically to adult (hits, frowns, pushes)
_____1.2.3 Expresses hostility verbally
_____1.2.4 Ignores adult when adult attempts to interact with child

2.0.00 CHILD/CHILD

2.1.00 Curiosity

During the initial week of observation, mark only if observed. At the final observation, carry over the old observations and add any new behaviors observed in the interim.

_____2.1.1 Observes peer on computer
_____2.1.2 Speaks or signs to peer on computer
_____2.1.3 Questions peer about activity (signing counts)

2.2.00 Cooperative Behavior

_____2.2.1 Waits for turn at computer
_____2.2.2 Takes turn when working with another child at computer
_____2.2.3 Shares ideas
_____2.2.4 Explains or demonstrates to another child how an input device and/or software program works
_____2.2.5 Can work cooperatively with two or three other children on the computer

2.3.00 Competitive Behavior

_____2.3.1 Races to computer
_____2.3.2 Pushes peer away
_____2.3.3 Manipulates, controls, directs others
_____2.3.4 Monopolizes computer
_____2.3.5 Expresses frustration physically to peer (hits, frowns, pushes)
_____2.3.6 Expresses frustration verbally to peer

3.0.00 CHILD/COMPUTER

3.1.00 Initial Contact

During the end of the year observation, behaviors observed during the initial week should be carried over.

_____3.1.1 Attends to computer
_____3.1.2 Moves to improve view of monitor
_____3.1.3 Talks self through the program
_____3.1.4 Attends to auditory stimulus from computer
_____3.1.5 Talks to computer
_____3.1.6 Activates alternative input devices, if needed

3.2.00 Resists Computer

Resistant behaviors should not be carried over. These should be marked during the final observation only if observed at that time.

_____3.2.1 Refuses to touch computer or peripherals
_____3.2.2 Pushes away from computer
_____3.2.3 Turns face away from computer
_____3.2.4 Attempts to harm or disable computer

3.3.00 Demonstrates Cause/Effect Relationships Between Input Device and Monitor

_____3.3.1 Looks at monitor to see what happens when input device is actuated
_____3.3.2 Uses input device with intent

3.4.00 Expressive Behavior

_____3.4.1 Expresses enthusiasm physically (smiles, claps hands, waves arms)
_____3.4.2 Expresses enthusiasm verbally

3.5.00 Rules and Directions

_____3.5.1 Can state rules for computer use when asked (Ask then write the response in the space below.)
_____3.5.2 Does not turn computer off indiscriminately
_____3.5.3 Activates input device appropriately and carefully
_____3.5.4 Handles computer with care
_____3.5.5 Handles CD appropriately

3.6.00 Independent Computer Use

_____3.6.1 Can work alone at task for at least five minutes

3.7.00 Planning Abilities

_____3.7.1 Names expected results from the computer
_____3.7.2 Makes choices
_____3.7.3 Evaluates program
_____3.7.4 Takes action to reach desired goal with the computer

3.8.00 Comments

_____3.8.1 Statement of rules if any:

_____3.8.2 Why do you use the computer?

Reading, Writing, and Computers

1. How often do you read books? magazines? newspapers?

2. List newspapers or magazines, including children's, you subscribe to.

3. Where does your family obtain books to read?

4. What is the number of books in your home for adults? children?

5. How old was your child when you began sharing books with him/her?

6. How often does a family member read aloud to your child?

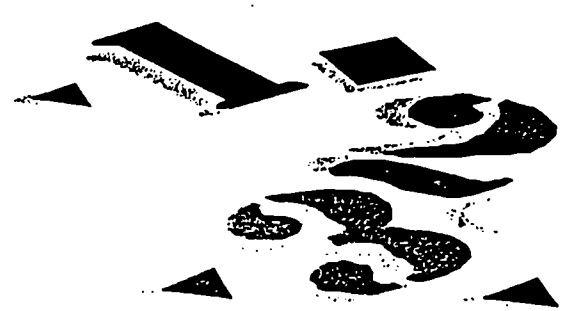
   Do you have a regular time for reading in your home?

7. How often does your child pretend/attempt to read aloud to a family member?

8. Does your child have a favorite book?

   If so, what is the title?

9. Does your child follow the story by pointing to the text or pictures?



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10. Does your child listen to stories on cassettes?

11. How often does your child look at books or read by him/herself?

12. How does your child use books in his/her play activities?

13. Does your child request to go to the library or request new books?

14. Does your child try to print letters, words, or stories?

    Examples?

15. Do you model reading in your daily activities (recipes, game instructions, road signs, etc)?

16. Does your child request an adult to create signs or symbols for their play activities?

    In what ways?

17. Where does your child use a computer? How is it used?
    home_____
    school_____
    other_____

18. Do you use a computer? If so, where?

19. How do you use a computer (Word processing, database, newsletter, letter, other)?

20. Does your child watch TV?

    How many hours a day?

21. What are your child's favorite TV programs?

22. List people who live in your household (include relationships to the child).

23. What is the highest level of school completed by
mother?

father?

24. Mother's occupation:_____

Father's occupation:_____

25. Rank by importance what you want your child to learn in preschool. (Rank 1 to 4, 1 being the highest)

Play___Music___Reading___Social Skills___Other_____

26. Please add other important information about your child's reading, writing, or technology experience that you would like for us to know.

This assessment is adapted from work described in the following references:

Meyer, Linda A. (and others) (1990) Home Support for Emerging Literacy: What Parents Do That Correlates with Early Reading Achievement Technical Report No. 518, Office of Educational Research and Improvement (Ed), Washington, DC.

Toomey, D. (1992) Short and medium run effects of parents reading to preschool children in a disadvantaged locality. ERIC No. ED 346 439.

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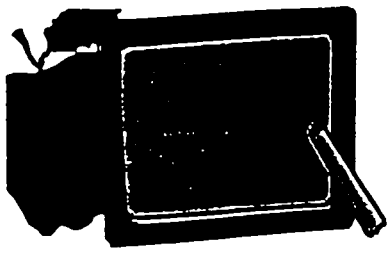


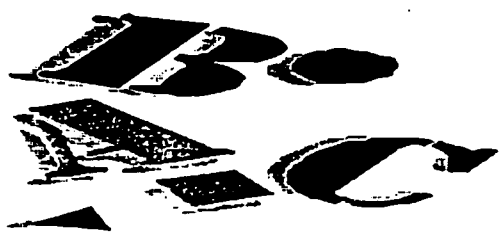
Kids and Computers

1. What does your child say about the computer at home?

2. Have you seen a change in the way your child uses books?

3. How does your child involve writing in play at home?

4. How do you feel about the computer being in your child's classroom?



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What I liked best about the computer...

(Please return to school)

Teacher Learning Styles Checklist

	Yes	No	Remarks/Examples
1. Learning objectives/expectations for children are appropriate for the age and developmental level of each child.			
2. Learning objectives/expectations are based on ongoing observation of children. (These observations are used to determine the need and interest levels in physical, intellectual, language, and social/emotional areas of development.)			
3. Learning objectives/expectations are modified to accommodate children's individual abilities, learning styles and needs.			
4. Learning objectives/expectations for children are used to document children's progress.			
5. Daily plans includes individual experiences.			
6. Daily plans includes small group experiences			
7. Daily plans include opportunities for total group experiences appropriate to the developmental level of the children.			
8. Group experiences for developing skills and concepts are organized so that each child has individual attention and is free to express ideas.			
9. The schedule provides activities that are balanced (active/quiet; group/individual; indoor/outdoor)			
10. The schedule provides activities that are developmentally appropriate.			
11. The schedule provides activities that are designed so that all children experience success.			

12. Individualized programs planned for children with special needs are incorporated within the daily experiences.

13. All children have opportunities during each day to make choices in selecting activities and materials.

14. All children are offered opportunities to structure their own thinking and gain mastery over their environment by

    Observe

    Explore

    Discover

    Question

    Problem solve

    Share experiences

    Initiate activities

    Make choices

15. Concrete experiences are provided that help children develop time, space, classification, and number concepts.

16. All children are helped to acquire and use language to communicate information, thoughts and feelings, and to talk and listen with understanding.

17. Children with little expressive language are encouraged to communicate with sounds, gestures or other forms of communication.

Yes	No	Remarks/Examples

18. Attempts are made to recognize the child's individuality by responding appropriately to efforts to communicate. If needed, staff member learns alternative forms of communication.

19. Books are available to children for use during free choice during each day.

20. All children have a variety of fine motor experiences (i.e. clay, puzzles, peg boards, etc) to encourage development of hand-eye coordination.

21. All children have opportunities during each day for gross motor activities such as running, jumping, climbing, balancing, pedaling, throwing and catching.

22. All children are engaged in a wide range of experiences in each of the following:

    Music and movement

    Art

    Dramatic play

    Cooking

    Quiet conversation with adults

23. There is little or no emphasis on patterns or final product in the use of art media.

24. Outdoor experience is a part of the child's daily routine (weather permitting).

Yes	No	Remarks/Examples

	Yes	No	Remarks/Examples
25. A wide variety of the following learning materials are available in good working condition and used regularly:			
Painting equipment (large brushes, large newsprint)			
Collage/paste/glue/scissors/crayons			
Dough/clay/accessories			
Blocks/accessories			
Sand/accessories			
Water/accessories			
Dramatic play accessories			
Manipulatives			
Books, records, and cassette tapes			
Cooking equipment			
Climbing equipment			
Wheel toys			
Balls			
24. An ample variety of materials is arranged on low, open shelves so that all children can make choices independently.			
25. There are clearly defined activity areas for various types of learning experiences.			
26. Staff relates to children in positive ways by evidencing pleasure and enjoyment in working with children.			

Yes	No	Remarks/Examples

27. Staff smile, touch, hold and speak to children at their eye level to foster communication.

28. Staff interact with all children in a positive manner, emphasizing their mutual contribution, cooperation, and independence.

29. Staff relate to children in positive ways by providing positive reinforcement, encouragement and supportive statements.

30. Staff encourage children at their different levels of abilities to develop self-reliance and make individual decisions regarding use of materials and equipment and participation in activities.

31. Staff provide a balance between activities initiated by children and those initiated by adults.

32. Staff actively involve children in helping to solve classroom problems by working through disagreements and conflicts at feeling/thinking levels.

33. Staff relates to children in positive ways by refraining from demeaning remarks to other adults or children about a child or child's behavior.

34. Staff help children cope with both success and failure by assisting them to express feelings in words or in acceptable actions.

35. Staff encourage independence in children based on child development principles. Staff foster independence in routine activities including:

    picking up toys

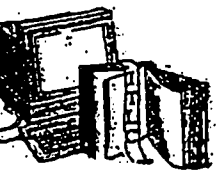
    wiping spills

    personal grooming (toilet/washing hands)

36. Staff listen to and converse frequently with children, asking open-ended questions and speaking individually to children.		
37. Staff establish and maintain a reasonable system of limits that are understood by children and adults.		
38. Staff use positive techniques for guidance including		
discussion/explanation		
redirection		
anticipation		
elimination of potential problems		
positive reinforcement		
encouragement rather than competition, comparison or criticism		
39. Staff abstain from corporal punishment or other humiliating or frightening discipline techniques.		
40. There is a process for orienting the child and parent to the program. It may include:		
pre-enrollment visit to the program		
parent orientation meetings		
other		

	Yes	No	Remarks/Examples
41. Various methods are used to facilitate good communication between home and school/center. These may include:			
newsletters			
conferences			
phone calls			
parent meetings			
other			
42. Family members have opportunities to be involved in the ongoing program with their children in some of the following ways:			
celebrations			
field trips			
sharing expertise, skills, interests, and family customs			
sharing a meal/snack			
assisting in the classroom			
special projects			
other			

Adapted from **Standard and Procedures for Voluntary Accreditation of Early Childhood Education Programs in Missouri.** ©Copyright 1984, Revised 1993. Missouri Department of Elementary and Secondary Education.



Teacher Literacy Questionnaire

Teacher's Name: _____

Classroom: _____ # of Children Served: _____

Directions: Please answer the following questions.

1. How many children's books do you have in your classroom?
2. How many children's big books do you have in your classroom?
3. How often do you read aloud to the children in your classroom?
4. What type of system is in place in your classroom in which students are given books to take home for a length of time to share with their families?
   How often are children encouraged to take books home?
5. Is there a system in place in your classroom in which students are given writing materials to take home?
   How often are they encouraged to take writing materials home?
6. How often do your children read aloud to you in an informal setting (e.g. sharing time)?
7. Are the children encouraged to follow the story by pointing to the text or pictures?
   In what kind of setting would this take place?
8. Do you use oral storytelling as an activity rather than reading to the children? How often?
9. How often do you incorporate oral storytelling by children into activities in your classroom?
   How is this done?
10. How often do you incorporate nursery rhymes into your classroom activities?
    How is this done?
11. How often do you use puppets or props that children can use during storytelling activities?
12. Do you use a computer during storytime activities?
    How often and in what ways do you use the computers?
13. Do you encourage the children to use the computer for story activities?
    if so, in what way?
14. How often do you publish books of student-created stories in your classroom?
    How often and in what ways do you use the computer?

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15. Do you use a computer to publish books?
If you do, what types of programs do you use?

16. Do you encourage the children to use the computer for writing activities?
If so, in what way?

17. What software do you use for developing literacy skills?

18. Is there a quiet reading center in your classroom where the children can go to look through books or read?

19. How often are children encouraged to use books in play activities in your classroom?

20. How often does your class go to the school library? Length of time?

21. Do you use environmental print in activities in your classroom?
If so, how often do children spontaneously use environmental print and labels in classroom activities?

22. How often do the children in your classroom use writing in play activities in your classroom?

23. Do your children request writing from you to use in play activities?

24. How do you model writing behaviors for the children in your classroom?

25. Do you take field trips? If so, where?

26. Do you have a listening library with cassettes?
In what ways do you use the tapes?

27. Do you have videos or videodisc of children's stories? What kinds of videos?

28. Do you label objects in your classroom?

30. Do you display a printed form of the children's names to use for activities in your classroom?

31. How do you model reading behaviors for the children in the classroom?

32. List the ways that you access the developing literacy of the children within your classroom?

33. How do you keep current in children's literature and emerging literacy?

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SUGGESTED FORMAT FOR FIELD NOTES

CLASSROOM DESCRIPTION

*Include a comprehensive description of the classroom during the first observation visit.
*After the first visit, note any changes in the classroom.
*Record in this section the number of students, program assistant(s), and teacher(s) that were in the classroom during the visit.

UNOBTRUSIVE CIRCUMSTANCES

*Use this section to note any peculiar circumstances that may have impacted the observation visit. For example, 'there was a new student in the classroom today.'

LESSON OBJECTIVE(S) AND ACTIVITIES

*Note who was leading the activity and what kind of activity occurred (e.g. group -vs- individual activity).
*Record the subject of the activity (i.e. lesson objectives, short -vs- long term activity goals, etc.).
*Comments from the person who lead the activity would be beneficial --if not imperative-- here.
*Note the equipment, software, and order of activities during the technology observation.

NARRATIVE

*Write very descriptively (i.e. only "state the facts" in this section; don't make any conclusions).
*Each activity should be in a separate paragraph so it can be pulled apart for content analysis.
*Record teacher prompts (verbal and nonverbal) and transitions.
*Refer to the kids by code # and refer to the teachers by their proper name (e.g. Mr. Smith).

CLASSROOM IMPRESSIONS

*Note impressions about the teacher(s), child, and program assistant(s).
*Here is the place where subjectivity is allowed.
*Record any notes that may be used for future reference.
*Note any impressions or interpretations about the visit.

TEACHER SUMMARY

*Record how the teacher felt about the activities that took place during the visit (this means that you will have to probe the teacher after the activity or activities have occurred)> Use quotes!

DURATION OF TECHNOLOGY USE FOR OBSERVATION

*Pull the technology duration information off the time counter on the VCR.
*Note the time of each different technology activity. For example, if two different software programs were used during the observation, note that software program A lasted x minutes and that software program B lasted x minutes.

Appendix B: Coding System

Objectives Codes for DBase

1000 Important Items not in any other code category.

2000 Which sections of the ITLC are most effective in promoting positive changes in children and classrooms

2100 Section I - Commercial software
- 2101 Oral Communication
  - 2101.1 Uses appropriate vocabulary
  - 2101.2 Self talk/self direction
  - 2101.3 Carries on a conversation
  - 2101.4 Labels
- 2102 Tells a story
  - 2102.1 Describes characters
  - 2102.2 Retells a story
  - 2102.3 Articulates key concepts
  - 2102.4 Dictates stories
- 2103 Draws
- 2104 Looks at or "Reads" a book (imitating)
- 2105 Writes
  - 2105.1 Emergent writing
  - 2105.2 Invented spelling
  - 2105.3 Prints letters/words
  - 2105.4 Emergent keyboarding (imitating/exploration)
  - 2105.5 Keyboard (choosing letters with intent)
- 2106 Solves problems
- 2107 Makes judgments
- 2108 Listens
- 2109 Attends
- 2110 Uses related literacy materials
- 2111 Predicts sequence and outcomes
- 2112 Recognizes letters
- 2113 Identifies and/or reads words
- 2114 Identifies environmental print
- 2115 Shares/takes turns
- 2116 Social interaction among children
- 2117 Social interaction between children and adults
- 2118 Positive child directed social interaction/ communication between children and adults.
- 2119 Positive adult directed social interaction/ communication between children and adults.
- 2120 Negative child directed social interaction/ communication between children and adults.
- 2121 Negative adult directed social interaction/ communication between children and adults.

2200 Section II - HyperStudio, own classroom

- 2201 Oral Communication
  - 2201.1 Uses appropriate vocabulary
  - 2201.2 Self talk/self direction
  - 2201.3 Carries on a conversation
  - 2201.4 Labels
- 2202 Tells a story
  - 2202.1 Describes characters
  - 2202.2 Retells a story
  - 2202.3 Articulates key concepts
  - 2202.4 Dictates stories
- 2203 Draws
- 2204 Looks at or "Reads" a book (imitating)
- 2205 Writes
  - 2205.1 Emergent writing
  - 2205.2 Invented spelling
  - 2205.3 Prints letters/words
  - 2205.4 Emergent keyboarding (imitating/exploration)
  - 2205.5 Keyboard (choosing letters with intent)
- 2206 Solves problems
- 2207 Makes judgments
- 2208 Listens
- 2209 Attends
- 2210 Uses related literacy materials
- 2211 Predicts sequence and outcomes
- 2212 Recognizes letters
- 2213 Identifies and/or reads words
- 2214 Identifies environmental print
- 2215 Shares/takes turns
- 2216 Social interaction/communication among children
- 2217 Social interaction/communication between children and adults
- 2218 Positive child directed social interaction/ communication between children and adults.
- 2219 Positive adult directed social interaction/ communication between children and adults.
- 2220 Negative child directed social interaction/ communication between children and adults.
- 2221 Negative adult directed social interaction/ communication between children and adults.

2300 Section III - HyperStudio, other classrooms

- 2301 Oral Communication
  - 2301.1 Uses appropriate vocabulary
  - 2301.2 Self talk/self direction
  - 2301.3 Carries on a conversation
  - 2301.4 Labels
- 2302 Tells a story
  - 2302.1 Describes characters
  - 2302.2 Retells a story
  - 2302.3 Articulates key concepts
  - 2302.4 Dictates stories
- 2303 Draws
- 2304 Looks at or "Reads" a book (imitating)
- 2305 Writes
  - 2305.1 Emergent writing
  - 2305.2 Invented spelling
  - 2305.3 Prints letters/words
  - 2305.4 Emergent keyboarding (imitating/exploration)
  - 2305.5 Keyboard (choosing letters with intent)
- 2306 Solves problems
- 2307 Makes judgments
- 2308 Listens
- 2309 Attends
- 2310 Uses related literacy materials
- 2311 Predicts sequence and outcomes
- 2312 Recognizes letters
- 2313 Identifies and/or reads words
- 2314 Identifies environmental print
- 2315 Shares/takes turns
- 2316 Social interaction/communication among children
- 2317 Social interaction/communication between children and adults
- 2318 Positive child directed social interaction/ communication between children and adults.
- 2319 Positive adult directed social interaction/ communication between children and adults.
- 2320 Negative child directed social interaction/ communication between children and adults.
- 2321 Negative adult directed social interaction/ communication between children and adults.

2400 Section IV - Graphics and story-making
- 2401 Oral Communication
  - 2401.1 Uses appropriate vocabulary
  - 2401.2 Self talk/self direction
  - 2401.3 Carries on a conversation
  - 2401.4 Labels
- 2402 Tells a story
  - 2402.1 Describes characters
  - 2402.2 Retells a story
  - 2402.3 Articulates key concepts
  - 2402.4 Dictates stories
- 2403 Draws
- 2404 Looks at or "Reads" a book (imitates)
- 2405 Writes
  - 2405.1 Emergent writing
  - 2405.2 Invented spelling
  - 2405.3 Prints letters/words
  - 2405.4 Emergent keyboarding (imitating/exploration)
  - 2405.5 Keyboard (choosing letters with intent)
- 2406 Solves problems
- 2407 Makes judgments
- 2408 Listening
- 2409 Attending
- 2410 Uses related literacy materials
- 2411 Predicts sequence and outcomes
- 2412 Recognizes letters
- 2413 Identifies and/or reads words
- 2414 Identifies environmental print
- 2415 Shares/takes turns
- 2416 Social interaction/communication among children
- 2417 Social interaction/communication between children and adults
- 2418 Positive child directed social interaction/ communication between children and adults.
- 2419 Positive adult directed social interaction/ communication between children and adults.
- 2420 Negative child directed social interaction/ communication between children and adults.
- 2421 Negative adult directed social interaction/ communication between children and adults.

2500 Section V - Outside of ITLC observable behaviors
- 2501 Oral Communication
  - 2501.1 Uses appropriate vocabulary
  - 2501.2 Self talk/self direction
  - 2501.3 Carries on a conversation
  - 2501.4 Labels
- 2502 Tells a story
  - 2502.1 Describes characters
  - 2502.2 Retells a story
  - 2502.3 Articulates key concepts
  - 2502.4 Dictates stories
- 2503 Draws
- 2504 Looking at or "Reading" a book (imitating)
- 2505 Writes
  - 2505.1 Emergent writing
  - 2505.2 Invented spelling
  - 2505.3 Prints letters/words
  - 2505.4 Emergent keyboarding (imitating/exploration)
  - 2505.5 Keyboard (choosing letters with intent)
- 2506 Solves problems
- 2507 Makes judgments
- 2508 Listens
- 2509 Attends
- 2510 Uses related literacy materials
- 2511 Predicts sequence and outcomes
- 2512 Recognizes letters
- 2513 Identifies and/or reads words
- 2514 Identifies environmental print
- 2515 Shares/takes turns
- 2516 Social interaction/communication among children
- 2517 Social interaction/communication between children and adults
- 2518 Positive child directed social interaction/ communication between children and adults.
- 2519 Positive adult directed social interaction/ communication between children and adults.
- 2520 Negative child directed social interaction/ communication between children and adults.
- 2521 Negative adult directed social interaction/ communication between children and adults.

2600 Section VI - Not implementing the ITLC, but having technology in place

- 2601 Oral Communication
  - 2601.1 Uses appropriate vocabulary
  - 2601.2 Self talk/self direction
  - 2601.3 Carries on a conversation
  - 2601.4 Labeling
- 2602 Tells a story
  - 2602.1 Describes characters
  - 2602.2 Retells a story
  - 2602.3 Articulates key concepts
  - 2602.4 Dictates stories
- 2603 Draws
- 2604 Looks at or "Reads" a book (imitates)
- 2605 Writes
  - 2605.1 Emergent writing
  - 2605.2 Invented spelling
  - 2605.3 Prints letters/words
  - 2605.4 Emergent keyboarding (imitating/exploration)
  - 2605.5 Keyboard (choosing letters with intent)
- 2606 Solves problems
- 2607 Makes judgments
- 2608 Listens
- 2609 Attends
- 2610 Uses related literacy materials
- 2611 Predicts sequence and outcomes
- 2612 Recognizes letters
- 2613 Identifies and/or reads words
- 2614 Identifies environmental print
- 2615 Shares/takes turns
- 2616 Social interaction/communication among children
- 2617 Social interaction/communication between children and adults
- 2618 Positive child directed social interaction/ communication between children and adults.
- 2619 Positive adult directed social interaction/ communication between children and adults.
- 2620 Negative child directed social interaction/ communication between children and adults.
- 2621 Negative adult directed social interaction/ communication between children and adults.

2700 Section VII - Classrooms without technology in place

- 2701 Oral Communication
  - 2701.1 Uses appropriate vocabulary
  - 2701.2 Self talk/self direction
  - 2701.3 Carries on a conversation
  - 2701.4 Labels
- 2702 Tells a story
  - 2702.1 Describes characters
  - 2702.2 Retells a story
  - 2702.3 Articulates key concepts
  - 2702.4 Dictates stories
- 2703 Draws
- 2704 Looks at or "Reads" a book (imitating)
- 2705 Writes
  - 2705.1 Emergent writing
  - 2705.2 Invented spelling
  - 2705.3 Prints letters/words
  - 2705.4 Emergent keyboarding (imitating/exploration)
  - 2705.5 Keyboard (choosing letters with intent)
- 2706 Solves problems
- 2707 Makes judgments
- 2708 Listens
- 2709 Attends
- 2710 Uses related literacy materials
- 2711 Predicts sequence and outcomes
- 2712 Recognizes letters
- 2713 Identifies and/or reads words
- 2714 Identifies environmental print
- 2715 Shares/takes turns
- 2716 Social interaction/communication among children
- 2717 Social interaction/communication between children and adults
- 2718 Positive child directed social interaction/ communication between children and adults.
- 2719 Positive adult directed social interaction/ communication between children and adults.
- 2720 Negative child directed social interaction/ communication between children and adults.
- 2721 Negative adult directed social interaction/ communication between children and adults.

Section VIII - Teachers, Staff and Families

3000 What conditions are effective/ineffective to implement the ITLC?

- 3001 Teacher effective
- 3002 Classroom effective
- 3003 Children effective
- 3004 School Staff effective
- 3005 Administrators effective
- 3006 Trainers (Researchers)effective

- 3007 Teacher ineffective
- 3008 Classroom ineffective
- 3009 Children ineffective
- 3010 School Staff ineffective
- 3011 Administrators ineffective
- 3012 Trainers (Researchers) ineffective

4000 What software do children, teachers and staff prefer?

4001 What software do children, teachers and staff **not** prefer?

5000 Teachers and Staff - miscellaneous code (does not apply below)

5001 Do teachers and school staff see changes in children's literacy behaviors over time?

5002 What skills do teachers and school staff need to implement the ITLC? What is the most effective path for acquisition of these skills?

5003 What teaching strategy options are effective in carrying out the ITLC?

5004 What problems do school staff encounter in carrying out the ITLC?

5005 Are there differences in teaching styles among school staff in four classroom types? If so, how does that affect children's progress toward literacy?

5006 What are the differences between teachers and school staff when transition occurs between classroom type?

6000 Families - miscellaneous code (does not apply below)

6001 Do families see changes in their children's literacy behaviors?

6002 Are parents satisfied with the ITLC in their children's classrooms?

6003 Do families change the literacy environment of the home during the study?

6004 Do family members participate in the ITLC at school? If so, in what ways? If not, why not?

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