Evaluating the Effectiveness of a Technology-Based Preschool Literacy Project: A Final Report of the LitTECH Outreach Project

by

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Executive Summary

LitTECH Outreach, a 3-year technology-based preschool literacy project was conducted by staff at the Center for Best Practices in Early Childhood (the Center), a research and development division of the College of Education and Human Services at Western Illinois University. Funded by the U.S. Department of Education's Office of Special Education Programs (OSEP)[1], LitTECH was based on *ideas that work*—the positive results of two research studies and two related research-based early childhood technology and literacy projects, all conducted by the Center. The project was designed to link the results of effective emergent literacy technology research findings to early childhood practice, thereby improving emergent literacy practices for young children with disabilities.

LitTECH was replicated in 10 sites: three sites in Year 1, eight sites in Year 2, and eight sites in Year 3. Some sites participated more than one year. Nine sites were in Illinois and one was in Missouri. Sites included early childhood centers, a Head Start program, pre-K programs, and special education cooperative classrooms. The total teacher sample over the 3-year period was 92 treatment classroom teachers (some participating more that one year) and 37 comparison classroom teachers. Treatment classrooms over the 3 years served 1,549 children (some more than one year). Comparison classrooms served 609 children.

LitTECH positively impacted teachers and children in treatment classrooms, as demonstrated by the data collected during the 3-year project. Treatment teachers implemented important components of the LitTECH curriculum into their classrooms. They established appropriate classroom computer center environments, integrated technology tools and software into the classroom curriculum, and made use of technology to facilitate communication between home and school.

Treatment teachers learned valuable technology skills that allowed them to effectively implement technology activities with a diverse range of students. Over the course of their involvement with LitTECH, these teachers became adept at using technology to manage student learning; using technology to address content and student technology standards; designing developmentally appropriate learning opportunities that apply technology-enhanced instructional strategies to support diverse needs of learners; using technology resources to collect and analyze data, interpret results, and communicate findings to improve instructional practice and maximize learning; and applying multiple methods of evaluation to determine students' appropriate use of technology resources for learning, communication, and productivity.

Treatment children saw greater gains in emergent literacy skills than their comparison

[1] LitTECH Outreach PR#H324R30013, funded by the Office of Special Education Programs, U.S. Department of Education

counterparts. These skills included interacting with book and print materials, demonstrating an understanding of story, book handling skills, responding to pictures and print, and demonstrating emergent writing behaviors. Treatment children also had greater gains in technology skills particularly in the areas of basic operations and concepts, using technology productivity tools, and using technology problem-solving and decision-making tools.

Parents reported that involvement in the literacy technology program provided benefits to their children. Reported benefits included improved language development, as well as communication, listening, reading, and writing skills.

The study demonstrated the LitTECH model positively impacts the development and acquisition of emergent literacy skills of young children with and without disabilities. The key to acquisition is that the model be implemented in the way that it is intended. The classroom environment must be set up to encourage exploration, and software must be critically evaluated for appropriateness and individualized for each group of children.

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LitTECH Outreach was a 3-year OSEP-funded technology-based preschool literacy project conducted by staff at the Center for Best Practices in Early Childhood (the Center), a research and development division of the College of Education and Human Services at Western Illinois University. The major goal of LitTECH was to link the results of effective emergent literacy technology research to early childhood practice, thereby improving emergent literacy practices for young children with disabilities.

LitTECH was based on the positive results of two research studies and two related research-based early childhood technology and literacy projects, all conducted by the Center. The Early Childhood Emergent Literacy Technology Research Study[2] developed and tested the Interactive Technology Literacy Curriculum (ITLC), the foundation for the LitTECH model. The ITLC was developed and studied over 3 years in 16 half-day classes with 255 preschool children with disabilities and eight teachers. Four classes without technology served as a comparison group. Children at the ITLC sites made significant gains in emergent literacy behaviors and in positive social interactions. Children recognized their own names, names of others, and identified environmental print in software programs. They pretended to 'read' stories, asked questions, made comments, and carried on conversations—skills that mark the beginnings of later success with literacy (Hutinger et al., 1998).

LitTECH's procedures, materials, and evaluation tools were then successfully used in a model demonstration project[3] and an outreach project[4], which yielded similar results for 2,553 children (Hutinger, Bell, Johanson, & McGruder, 2002; Hutinger, Robinson, Schneider, & Johanson, 2002). Procedures and materials were next studied in a Steppingstones Phase 3 Research on Implementation Project[5] in order to replicate and validate the original research findings. The model was replicated in 17 classrooms. Eighteen replication teachers served 438 children with disabilities or at-risk. Results demonstrated that technology provided access to literacy activities that benefited young children, whether they had disabilities or were at risk. Across the 3-year period, children in treatment groups made gains in aspects of both literacy and technology use (Hutinger, Bell, Daytner, & Johanson, 2005, 2006).

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[2] PR # H180G40078
[3] The Early Childhood Interactive Technology Literacy Curriculum Project, PR # H024B50064
[4] LitTECH Interactive Outreach, PR #H024D70020
[5] Disseminating and Replicating an Effective Emerging Literacy Technology Curriculum (ELiTeC), PR #H327A000036

Theoretical Framework

The following sections discuss the theoretical and empirical support for emergent literacy, benefits of technology use, and integrated curriculum — all important factors of the LitTECH model.

Emergent Literacy

Learning to read is a complex process. Children must learn the principles and rules of a culture's writing system in order to learn to read (Snow, Burns, & Griffin, 1998). Children must learn the alphabet as a symbol system for sounds, the rules that govern how letters combine to make words and words combine to make sentences, how to find meaning in text, and how to reflect on language to gain metalinguistic insight. Children accomplish these skills in a relatively short period of time by observing and interacting with other readers and writers as well as through their own experiences as readers and writers (Sulzby & Teale, 1991). Experiences with storybook reading, discussions about books, listening comprehension, and writing are crucial in early literacy development (Bus, van Ijzendoorn, & Pellegrini, 1995).

Prior to the 1980's, preschool literacy instruction was based on a reading readiness approach, emphasizing decontexualized and sequenced teaching of reading subskills, such as the relationship between sounds and the visual characteristics of print, while ignoring the functions of print and writing (van Kleeck, 1990). In the mid 1980's, views and educational practices regarding early childhood literacy development made a dramatic shift to the emergent literacy perspective. Proponents of the emergent perspective concluded: "(a) listening, speaking, reading and writing abilities develop concurrently and interrelatedly, not sequentially; (b) the functions of reading and writing are as much a part of literacy learning as are the formal skills; (c) children's early behaviors are a legitimate phase, rather than a precursor to literacy; and (d) these behaviors and conceptualizations develop in predictable ways toward conventional literacy" (Teale, Hiebert, & Chittenden, 1987, p. 772). The emergent literacy perspective recognizes, and seeks to build upon, the naturally occurring literacy behaviors exhibited by children prior to formal instruction (Barclay, 1990; Lyon 1997; Strickland, 1990; Sulzby, 1986; Teale et al., 1987). Emphasis is placed on the developmental progression of reading and writing skills and the importance of children's participation in literacy activities that are personally meaningful and functional (Burns, Griffin, & Snow, 1999; Morrow, 1997a; Strickland, 1990). Most researchers now accept the emergent literacy perspective to explain literacy acquisition (Mason & Sinha, 1993). In 2000, the two major national organizations that guide preschool literacy education, the International Reading Association (IRA) and the National Association for the Education of Young Children (NAEYC), published a joint

position statement encouraging the use of emergent literacy as the foundation for instruction and assessment in preschool classrooms (Neuman, Copple, & Bredekamp, 2000). Further support for the emergent literacy perspective comes from the findings of the National Early Literacy Panel, a panel designed to extend the National Reading Panel's work to children younger than kindergarten age. This panel reports "well-integrated, developmentally appropriate, and engaging opportunities" in literacy help to build the foundations for reading and writing (Strickland & Shanahan, 2004, p. 76).

Literacy research shows that the children most likely to experience reading difficulties during the primary grades are those beginning school with less prior knowledge and skills in the areas of letter knowledge, phonological sensitivity, familiarity with the basic purposes and mechanisms of reading, and language ability (Adams, 1990; Snow et al., 1998). Many children with oral language delays and impairments have significant literacy problems before they enter first grade (Scarborough & Dobrich, 1990). Koppenhaver and Erickson (1998) identified three literacy problems affecting children with a wide range of disabilities, including: (1) difficulty learning to read; (2) receiving instructional approaches that address the study of words in isolation and rely on workbook activities; and (3) teachers who believe children with disabilities should be taught separately from their peers. Most children who have reading difficulties have been read to only one-tenth as often as children who are more successful readers (Adams, 1990). Children with disabilities are especially likely to lack reading exposure (Marvin, 1994). Those with significant speech impairments lag behind their peers in literacy development because they often have fewer opportunities to learn how to construct meaning from stories (Light & Kent-Walsh, 2003). In addition, literacy is not likely to be a part of intervention plans for children with disabilities, and their teachers are often not aware of emergent literacy research (Erickson & Koppenhaver, 1995; Koppenhaver & Erickson, 1998). Even if teachers of children with disabilities know about appropriate early literacy practices, they may question using such practices with their students (Neuman & Roskos, 1998; Patzer & Pettegrew, 1996).

An extensive review of literacy research by the National Early Literacy Panel (Strickland & Shanahan, 2004) identified predictors of future literacy success that included: alphabetic knowledge, phonological and phonemic awareness, print knowledge, oral language development, and invented spelling. Literacy research indicates that development of these skills best occurs during authentic reading and writing activities (Ehri et al., 2001; Jalongo, 2004; Morrow, 1997a; Neuman et al., 2000; Peterson, Taylor, & Hansen, 2002; Snow et al., 1998; Stahl, 1998).

Alphabetic principle refers to "cognitive insights into the systematic relationships between printed letters and spoken sounds" (Reutzel, 1992, p. 20). Preschool children, with no formal training,

learn much about letter-to-sound correspondence. In fact, many children understand the alphabetic principle prior to fully mastering letter-to-sound correspondences (Adams, 1990). Children learn this information from activities in the environment, including listening to books, being exposed to various types of print, playing rhyming games, and participating in writing activities. Knowledge of the alphabetic principle, a critical step in independent reading, is vitally important (Adams, 1990). "Failure to grasp that written spellings systematically represent the sounds of spoken words makes it difficult not only to recognize printed words but also to understand how to learn and to profit from instruction" (Snow et al., 1998, p. 315).

Phonological awareness is an understanding of the sounds of language (Invernizzi, 2003; Wolfe & Nevills, 2004). It arises from the ability to reflect on language independent of meaning and to manipulate sounds. Phonological awareness encompasses many different skills including rhyming, recognizing initial sounds in words, onset-rime awareness, alliteration, segmenting words into sounds, and blending sounds into words (Adams, 1990; Invernizzi, 2003; Wolfe & Nevills, 2004). A strong foundation in phonological awareness positively affects the development of phonemic awareness and phonics in later years (Shanahan, 2005). Consequently, children with strong phonological awareness skills tend to be better readers (Adams, 1990; Juel, 1988; Neuman, 2002; Snow et al., 1998).

Concepts of print include understanding letters are different from words, letters are used to make words, spoken words can be represented in print form, there are spaces between words, print carries meaning, there is one-to-one correspondence between written and spoken words, and words are read from left to right and from top to bottom on the page (Adams, 1990; Barclay, 1994; Clay, 1991). Children learn concepts of print as they experience print, icons, and logos in the environment of their daily lives, and they often recognize concepts of print prior to having any formal instruction (Clay, 1991; Neuman & Roskos 1997; Yaden, Rowe, & MacGillivray, 2000). Since children who fail to develop an adequate understanding of print concepts during the preschool years are at risk for later reading difficulties, interventions for this age level should be designed to promote the development of print knowledge (Snow et al., 1998).

Book handling refers to children's physical manipulation of books (Schickedanz, 1999). The maturation of book handling skills tends to follow a typical trajectory (Allen & Marotz, 2003; Schickedanz, 1999; Wren, 2001), although many of the skills develop simultaneously. During book reading, children between 7 and 10 months old help an adult turn pages as well as turn pages awkwardly on their own. By 11-15 months of age, children are able to turn pages well, can turn an

inverted book right side up, and begin to participate in "play-reading." Beginning around 18 months, children are able to flip through a book from beginning to end, holding the book right-side up. Children from 18 to 24 months turn two to three pages of a book on their own at a time, while 25- to 36-month olds turn pages of a book one at a time. Children between 25 and 36 months also point to the text they are "reading" even though they may be telling a story unrelated to actual text. These children understand that text is read from top to bottom and from left to right. Children who have experiences with book handling during the preschool years have more successful literacy development during the elementary school years (Adams, 1990; Snow et al., 1998; Wells, 1981).

While alphabetic principle, phonological awareness, concepts of print, and book handling relate to children's text recognition, ***story comprehension*** deals with text comprehension. To be truly literate, children must be able to decode *and* understand. Identification of young children's comprehension abilities often occurs in the context of book reading. In this context, children answer questions about stories, retell stories they have heard, or pretend to read a story by using picture cues. Katims (1994) notes the importance of nonconventional pretend readings for children with disabilities. As children grow more sophisticated, they are able to figure out what a story is about and make predictions. Children's comprehension skills have a direct relationship to reading difficulties; children with reading difficulties retell stories that lack detail and complexity and contain less key information and cohesion (Merritt & Liles, 1987; Naremore, Densmore, & Harman, 1995; Weaver & Dickenson, 1982).

Emergent writing is often given less attention in the emergent literacy discussion, yet it is no less important in understanding children's literacy skills. Barclay (1990), drawing on the work of Clay (1975), identified seven stages of children's writing development, including: scribbling, mock handwriting, mock letters, conventional letters, invented spelling, approximated (phonetic) spelling, and conventional spelling. Scribbling, or making marks and then shapes on paper, is related to children's representation ability. As children gain experience, they realize that symbols can be combined with other symbols to build a more complex system. In time, children make mock letters or letter-like shapes resembling conventional letters, followed by the creation of conventional letters, using first uppercase and then lowercase letters. When children learn to write letters, they start to create words. Initial words often contain letters representing initial and sometimes ending sounds. Eventually, children's spellings begin to represent all sounds in a word and finally conventional pairings of letters. Children need daily opportunities to see words and letters being written and to practice making marks, symbols, letters, or words at all stages in order to effectively develop writing

skills (Barclay, Benelli, & Wolf, 1996). Through art and early writing experiences, young children develop the ability to make marks and produce symbols, foundational skills for later literacy development such as writing to communicate (Barclay, 1990; Dyson, 1986, 1990; Jalongo, 1992).

Benefits of Technology Use for Children with Disabilities.

Research and practical experience suggest that children with disabilities who have experiences with computers and other technologies are more likely to experience success than those without such access. Assistive technology equalizes learning opportunities for children with mild to severe disabilities. Intervening with computers and other technologies, including adaptive peripheral devices or specialized software, produces changes in young children (Derer, Polsgrove & Reith, 1996; Hutinger & Johanson, 2000; Hutinger, Johanson, & Stoneburner, 1996).

Evidence clearly points to the effectiveness of computers as access technology for young children with disabilities (Behrmann & Lahm, 1994; Brett, 1997; Clements, Nastasi, & Swaminathan, 1993; Godt, Hutinger, Robinson, & Schneider, 1999; Hutinger, 1996; Hutinger & Clark, 2000; Hutinger & Johanson, 1998; Hutinger & Johanson, 2000; Spiegel-McGill, Zippiroli, & Mistrett, 1989). Computers and adaptive devices assist children with disabilities to participate in the activities of daily life and to do many of the same things other children do—draw pictures, play games, and communicate.

Both literature and practice point to the important benefits of integrating technology into the preschool curriculum (Castellani & Jeffs, 2001; Gordon & Brown, 1996; Wright & Shade, 1994). Used appropriately, computers are valuable learning tools for preschool children (Haugland, 2000). Integrating computers and appropriate software into educational experiences positively impacts cognitive, social emotional, language, and motor development (Casey, 1997; Haugland, 1992; Hutinger, et al., 1998; Pressman, 1999; Van Scoter, Ellis, & Railsback, 2001). Children's language and social skills increase as they work together at the computer (Clements, et al., 1993; Davidson & Wright, 1994; Hutinger, et al., 1998; Hutinger, Bell, et al., 2002; Hutinger & Johanson, 1998).

Integrated Curriculum

Guidelines for both special and regular education support the concept of an *integrated curriculum* (DEC, 1993; NAEYC, 1996; Sandall, McLean, & Smith, 2000). An integrated curriculum has been shown to be an effective teaching method for children with disabilities (Gurganus, Janas, & Schmitt, 1995; Kataoka & Lock, 1995; Patton, 1995). Through an integrated curriculum, children with special needs can be included within the context of the regular program, even when the services of special education teachers and therapists are needed.

As its name implies, an integrated curricular approach integrates people, concepts, skills, and oral and written language in a natural, meaningful context. Through many and varied experiences relating to a common theme, young children with and without disabilities experience growth in conceptual understandings and process skills (Barclay et al., 1996; Barclay & Walwer, 1992; Manzo, 2001). When teachers target specific knowledge and skills to develop or enhance through participation in theme-driven activities, children show increased capacities for risk-taking, problem-solving, cooperative learning, sharing, and decision-making (Clements, 2001; Katz & Chard, 2000). By drawing upon young children's natural curiosity about the world around them, teachers and families can offer opportunities that allow children to construct meaning, confirm predictions, generate new questions, synthesize ideas, and make connections. Both the Project Approach (Helm & Beneke, 2003; Katz & Chard, 2000) and Reggio Emilia (Gandini, 1993) foster children's sustained involvement in hands-on projects related to areas of children's interest and connect learning to authentic and meaningful experiences.

LitTECH and Research Council Recommendations

LitTECH training and curriculum reflect the reading research recommendations for early childhood made by the National Research Council's Preventing Reading Difficulties in Young Children (Snow et al., 1998). Table 1 compares the Council's recommendations with the LitTECH curriculum and shows the many points of congruence.

Table 1

Research Recommendations and the LitTECH Curriculum

NRC Recommendations	**Components of LitTECH Training and Curriculum that Support NRC Recommendations**
1. Provide rich conceptual experiences that promote growth in vocabulary and reasoning skills.	A. A literacy-rich environment • Many and various books • Labels throughout the classroom • Pictures and posters with words B. Interactive software • Different levels promote reasoning skills • Text is highlighted and read to reinforce spoken to written word correspondence and left to right reading • Words and activities encourage verbal exchanges and vocabulary growth • Classroom software developed using authoring programs requires planning, discussion, reasoning, as well as written and verbal participation
2. Encourage lexical development, from early referential (naming) abilities to relational and abstract terms and finer-shaded meanings.	A. Meaningful experiences for children related to words and their meanings • Learning their names Sign-up sheet: Children "sign" their names by their pictures. • Learning classmates' names During circle time, children relate pictures to names • Learning everything has a name

	Names can be spoken and written The written word represents the object Objects are labeled throughout classroom environment B. Interactive software • Offers opportunities for children to socialize and discuss objects found in the stories, name the objects, and discuss their purposes in the story
3. Encourage development of listening comprehension skills and the kinds of syntactic and prose structures that preschool children may not yet have mastered.	A. Reading to children during circle time • Questioning children about the story • Asking children to predict what will happen next • Inviting children to participate as a group when the story has repeating phrases or sentences B. Interactive software • Offers opportunities for children to hear stories read, listen to and sing along with songs, experience rhymes, and play with words C. Authoring software • Offers children opportunities to create their own interactive stories. D. Off-computer curriculum activities related to electronic stories (e.g., acting out parts of the story) • Help children understand story content and structure
4. Encourage development of children's sense of story.	A. Print and electronic books • Children are introduced to story concepts (e.g., beginning, middle, end, characters, setting, conflict) through having print books read to them or by interacting with electronic books B. Dramatic play activities • Children participate in planning and acting out the story; they work on characters, settings, costumes, and plot sequence C. Authoring software • Children create interactive stories with sequence, characters, and words D. Art activities • Children tell stories through their drawings or about their drawings • Children use drawings to illustrate their stories
5. Encourage children's sensitivity to the sounds of language.	A. Singing/rhyming related to books used in classroom • Offers opportunities to play with the sounds in our language B. Interactive (Living Books) software • Reads stories aloud; highlights words • Lets children hear words over and over • Offers opportunities for children to predict and discuss events in stories C. Authoring software • Lets children record and replay sounds
6. Encourage development of children's concepts of print.	A. Print-rich environment • Objects labeled • Environmental print displayed • A variety of books available on many subjects; books displayed relate to software children are using • Paper and writing/drawing tools located in each center to encourage children's writing/drawing B. Interactive electronic software • Highlighted text promotes understanding of left to right; top to bottom • Spoken text promotes understanding that words are made up of sounds and have meaning
7. Encourage development of children's concepts of space, including directionality.	A. Interactive electronic books • Highlighted text • Promotes understanding that reading is done from left to right and from top to bottom • Demonstrates words are separated by spaces B. Variety of input devices

	• Mouse, touch tablet, alternate keyboard, switch • Allow children to explore the concept of space as they use the devices to maneuver through the software and interact with the variety of activities
8. Encourage development of children's fine motor skills.	A. Books • Handling books, turning pages B. Input devices for computer use • Mouse, touch tablet, alternate keyboard, switch • Encourage eye/hand coordination (visual tracking on monitor, pressing pictures on an overlay) C. Drawing/writing opportunities at all centers D. Computer sign-up sheet
9. Motivate children to read.	A. Books/interactive software • Read aloud to children daily. • Offer a wide variety of books and software on many subjects • Prepare a comfortable reading center where books are easily accessible • Provide adaptive books (e.g., with page turners) for children whose disabilities make book handling difficult • Encourage children to read aloud or to read along with the Living Books • Allow children to take books home • Allow children to share favorite books from home with classmates • Encourage children's storytelling/dramatic play • Create books with an authoring program, printing hard copies for classroom library and for families

Replication Sites

Both rural and urban school districts participated in LitTECH replication. Sites served children at risk and those with disabilities. Three sites, one rural, one suburban, and one urban, replicated the model in Year 1 (Spring semester, 2004) of the project. The rural site participated for 2 years. The others participated all 3 years.

Seven new sites were added in Years 2 and 3. Of the five new sites added in Year 2 (2005/2005 school year), four were located in rural communities and one in an urban community. Four of the five sites continued through Year 3. Two sites, both rural, joined the project in Year 3 (2005/2006 school year).

Table 2 shows the number of participants for each year of the study. The numbers of teachers and children in treatment and comparison classrooms are provided, as well as the number of participants for whom permission to collect data was received, and the number of participants for whom complete data sets were received. Further explanation is warranted as to why there are different numbers reported for each row. With respect to the teacher data, the *Total* rows and the *Total with Permission* rows are identical because only those teachers for whom permission was received were included in the study. However, although we received permission from all of the teachers, each year at least one teacher did not return a complete data set. Some reasons this occurred included: teachers being transferred to a different classroom or school, having a broken computer for

part of the school year, misplacing the data, and not complying with requests for data.

Table 2

LitTECH Outreach Participants Years 1 - 3

Year 1 Participants	Teachers		Children	
	Treatment	Comparison	Treatment	Comparison
Total	15	12	227	184
Total with Permission	15	12	88	68
Total with Complete Data	13	11	69	49
Year 2 Participants	Teachers		Children	
	Treatment	Comparison	Treatment	Comparison
Total	39	13	620	202
Total with Permission	39	13	372	53
Total with Complete Data	39	12	229	10
Year 3 Participants	Teachers		Children	
	Treatment	Comparison	Treatment	Comparison
Total	38	12	702	223
Total with Permission	38	12	339	47
Total with Complete Data	30	9	155	6

With respect to the child data, the *Total* rows and the *Total with Permission* rows do not align because LitTECH did not receive parent/guardian permission to collect data for all children in the classroom. We are uncertain as to why parents/guardians made this decision. Furthermore, in many cases we did not receive complete data sets for the children for whom we had permission. Some reasons included: child illness or absence during testing, children transferring in or out during pre or post testing, and teacher noncompliance with the data requests. It should be noted that, although there was variability in the number of children with complete data sets, *all* children in a treatment classroom had the potential to be impacted by the changes the teacher made as a result of LitTECH training. For all subsequent discussions of data, specific information regarding the number of participants included in each analysis will be provided.

Random Assignment of Sites' Classrooms

Upon notification of funding in September 2003, LitTECH Directors contacted the three Year 1 site administrators to obtain formal replication agreements from each site. Once replication agreements were on file, site administrators submitted names of teachers who agreed to participate in LitTECH. The names were printed on standard size business cards which were then drawn from a box to divide each site's teachers into treatment (replication) and comparison groups. Site

administrators were then given the names of teachers who had been randomly assigned to the treatment or comparison groups, and they notified the teachers. The same procedure was followed in Years 2 and 3.

To limit cross contamination, teachers in treatment classrooms were asked not to share information with comparison classrooms. In addition, administrators ensured that comparison teachers did not receive the technology that was purchased based on the treatment training and model implementation. After a classroom served as a comparison classroom for a year, the following year, its teacher participated in LitTECH replication training and the classroom became a treatment classroom. The only exceptions to this schedule were teachers whose classrooms were comparison classrooms in Year 3. These teachers had the option to receive replication training at the end of the project. Two of the four Year 3 comparison teachers attended training.

Role of Advisory Panel

In January 2004, five early childhood educators became part of the project's Advisory Panel. Two members dropped from the Panel at the end of the second year (December 2005). A parent member joined the Panel at the start of the third year (January 2006). Each spring, Panel members met to discuss their roles in the project. During Year 1, a listserv was established for dialogue and support between LitTECH Project Staff, Advisory Panel members, and replication teachers. Each Advisory Panel member moderated one listserv discussion each school year (see pages 12-13).

Advisory Panel members were invited to present or facilitate summer camp workshops. In 2004, one Advisory Panel member opened the 2-day workshop with an overview of project work and technology. Three panel members facilitated workshops each year on such topics as digital imaging, software review, and digital storytelling.

Advisory Panel members also provided a follow-up training for replication teachers and assisted in revising the *Technology Based on Standards (TABS)* and *Individual Literacy Assessment (ILA)*, two measures LitTECH used to collect child data. For information on these measures, see pages 17 and 18).

LitTECH Activities

Replication Training and Support Services

Replication training consisted of a series of workshops covering the content in five LitTECH modules. Replication training began for the first three replication sites in January 2004 and continued through December 2005.

The formal LitTECH training consisted of five separate modules. Module titles and brief

descriptions of content follow.

(1) *Building A Firm Foundation for Emergent Literacy*—Topics included the philosophy of emergent literacy, practices supporting emergent reading, practices supporting oral language, practices supporting early writing development, practices supporting emergent reading development, creating a literacy-rich environment, and emergent literacy assessment.

(2) *Designing the ITLC Environment*—Classroom technology topics included designing the computer environment with emergent literacy in mind, managing technology to promote literacy development, facilitating emergent literacy behaviors, and planning for adaptive devices. (Note: Modules 1 and 2 were generally covered together during the initial replication training session.)

(3) *Using Children's Software to Promote Emergent Literacy Behaviors*—Discussions and demonstrations focused on selecting software to support emergent literacy, understanding and using levels of software interactivity, evaluating software, and modifying software to meet individual literacy needs.

(4) *Integrating Technology into the Literacy Curriculum* – Discussions and demonstrations focused on selecting software to support emergent literacy, understanding and using levels of software interactivity, evaluating software, integrating technology into the curriculum, and creating computer-generated materials to support emerging literacy.

(5) *Using Authoring Multimedia Software to Enrich the Literacy Curriculum*—Content included an overview of a selected application, demonstrations of the application, information on how to develop and evaluate a multimedia program, and hands-on opportunities to create an electronic book.

Support services offered by LitTECH staff included face-to-face follow-up during classroom visits, electronic support via e-mail and listserv, as well as support via a toll-free phone line. The project website <www.wiu.edu/thecenter/littech> also provided information. Follow-up support contacts with replication teachers included 587 e-mail, 85 phone, 87 mail, and 273 personal contacts with a total of 932 follow-up contacts with site teachers. Follow-up content ranged from answering questions about action plans and training content to technical assistance about software and hardware.

During Year 1, the LitTECH listserv was created as a mechanism for sharing information and answering questions. Table 3 reflects the topics of the listserv postings over 3 years. Participants on the listserv included LitTECH Project staff, Advisory Panel members, and treatment teachers. The

total membership of the LitTECH listserv for the 3-year period was 75 members. Over this 3-year period, 153 messages were posted on the listserv. Twenty-four messages from LitTECH staff included announcements regarding training and workshop schedules, welcoming new participants, reminders of data due dates, teacher interview questions, and facilitating discussion topics. Twenty-two messages from Advisory Panel members included introducing discussion topics such as Technology Environments, *KidDesk*, Tips for Working with Families, Choosing Software for a Unit and/or Project, *HyperStudio*, Classroom Management of the Computer Center, Developmentally Appropriate Software, Using the Digital Camera in the Classroom, and Describing the Process: Creating the "Brown Bear" *Kid Pix* Slideshow.

Table 3

LitTECH Listserv Posts Over Three Years

Topics:	**Year 1**	**Year 2**	**Year 3**	**Total**
Announcements regarding LitTECH	2	8	14	**24**
Participant responses to announcements	2	5	11	**18**
Questions asked by LitTECH participants	0	2	2	**4**
Responses to questions asked by participants	0	2	1	**3**
Discussion topics introduced and led by Advisory Panel members	5	10	7	**22**
Participant responses discussion topics	11	9	3	**23**
LitTECH staff sharing information (FYI)	2	30	21	**53**
Participant responses shared information	0	5	1	**6**
Total Postings	**22**	**71**	**60**	**153**

Workshop Revisions and Development

Training modules and workshops were modified based on the participants' and sites' needs assessments that were conducted prior to or during the first training. Other modifications were undertaken as needed or requested. For example, if a school had purchased digital cameras, but the teachers lacked basic knowledge of digital camera use (e.g., using the camera's features, connecting camera to computer, downloading images) this information was integrated into one of the workshops. Or if the teachers had a good working knowledge of emergent literacy, the workshop was shortened to focus only on the impact of technology on emergent literacy. Or if the teachers all indicated a preference for a project approach to curriculum, the workshop focused more on a project approach to using technology and less on a thematic approach.

LitTECH developed one new workshop for training teachers to administer the revised *ILA* (see pages 25-26.) This training was based on the seven-page administration manual and a training DVD. The manual includes instructions, procedures, and criteria for scoring each part of the *ILA*. The DVD contains short videos for each *ILA* section. In the fall of 2005, 35 teachers from seven LitTECH sites received training on administering the *ILA*. Each teacher was given a copy of the *ILA Training*

Manual and watched the DVD showing examples related to each question. The DVD viewing was followed by a question and answer period for clarification. Then teachers were asked to fill out Parts II and III of the *ILA* assessment form while watching a DVD of an adult and child reading together in a testing scenario. Finally, teachers watched additional clips of testing scenarios until inter-rater reliability reached 90% agreement for each teacher.

Revised Curriculum

Revisions to *eMERGing Literacy and Technology: Working Together, Third Edition* (Hutinger, et al., 2001), the curriculum used in LitTECH training, were made in collaboration with other Center for Best Practices in Early Childhood staff with backgrounds in early childhood, literacy, and technology. The 492-page curriculum (completed in 1997 and revised in 1998 and 2001) contained nine chapters, plus references, resources, and appendices.

Changes that resulted in the Fourth Edition included the following: the Research Recommendations (see pages 7-9 of this report), originally in the Appendix, were moved to Chapter 1, "An Overview of Emergent Literacy," to show the reader how the LitTECH model corresponds to recommended research practices.

The *KidDesk* section was excluded from Chapter 2 ("Designing the Environment") because this kid-friendly desktop management software is no longer available except through a company that markets proprietary computer systems. Information on managing the classroom computer center and evaluating the computer environment was added to Chapter 2. Chapter 3 ("Software Selection") was revised by adding new software titles at each of the five Levels of Interactivity (Hutinger & Johanson, 1996). Older software titles that are now difficult to find were deleted from the interactivity lists.

Chapters 4 ("Integrated Curriculum Activities with Literacy-based Software") and 5 ("Integrated Activities with Tool and Graphics Software") were updated. New activities were added for six new software titles *(2 Review, Golly Gee Blocks, Morton Subotnich's Hearing Music, Kid Pix Deluxe 4, Stationary Studio,* and *Storybook Weaver Deluxe 2004)*. Twelve activities were eliminated from these chapters. The software on which they were based was either no longer being marketed or was outdated (i.e., not available for the newer PC and Mac operating systems). Other revisions to these chapters included adding and updating links to websites, adding children's book titles, and updating the software system requirements listed at the beginning of each activity.

Chapter 6 ("Multimedia Authoring Software," formerly titled "Curriculum Activities with *HyperStudio*") was changed to focus on a variety of multimedia authoring software and not just

HyperStudio. Other multimedia authoring software includes *Buildability, IntelliPics,* and *MediaBlender*.

Intellipics information was moved from Chapter 7 ("Customized Activities and Adaptations") to Chapter 6 because *Intellipics* comes under the definition of *Multimedia Authoring Software*. The original Chapter 8 ("Family Involvement") was removed from the curriculum, and its contents were integrated into Chapters 4 and 5. Chapter 9 ("Assessment") became Chapter 8. It now includes the revised *ILA* and the *ILA* training manual. The "References" and "Resources" chapters were also updated.

LitTECH Outreach Website

The LitTECH website was developed to disseminate information to the general public as well as to replication site staff. The LitTECH Outreach website is found at <www.wiu.edu/thecenter/littech>. The website features five areas:

(1) The **Home** section provides a list of project goals: (a) improve educational practice by linking tested research results to practice in replication sites; (b) provide access to the general curriculum, specifically related to literacy development, to children with disabilities; (c) promote awareness of the positive effects software and adaptations can have on children's literacy skills; (d) provide effective teaching/learning strategies for early childhood personnel and families; and (e) advance the knowledge and competencies of those using emergent literacy technology applications with children with disabilities. The link "Become a LitTECH Site," took interested visitors to a page explaining the steps needed to become a replication site.

(2) **About Us** provides information about the model, information for obtaining graduate credit hours or CPDUs for participating in model training, and benefits of using the LitTECH curriculum.

(3) Seven **Podcasts** were created specifically for families of children ages 3-5 to help them understand the importance of literacy development and offer suggestions for activities they could use at home with their children. The podcasts provide useful information for professionals as well. Podcasts include (a) "About the Center for Best Practices in Early Childhood;" (b) "Introduction to the Podcast Series and Description of Emergent Literacy;" (c) "Ways to Encourage Language Development" (includes ideas for using children's books to encourage language development); (d) "Activities to Support Oral Language Development;" (e) "Promoting Language Skills at the Computer;" (f) "Stages in Writing Development;" and

(g) "Using Picture Books to Inspire Writing."

(4) The **Resources** section targets replication site teachers. It contains eight .pdf files of instruments used for LitTECH data collection.

(5) Two *LitTECH News* newsletters are posted on the **Newsletter** section of the website. The newsletters included curriculum activities that support early literacy development as well as early learning standards; articles; information about the LitTECH model and its benefits; recommended websites; software and book reviews; technology tips from teachers; announcements of upcoming LitTECH listserv discussion topics, upcoming conference presentations given by LitTECH staff, and upcoming LitTECH training events; and contact information.

Method

Data Sources

LitTECH used a mixed methods approach, collecting and analyzing both quantitative and qualitative data to determine the effects of randomly assigned LitTECH treatment (replication) and comparison conditions on site staff and children. Table 4 lists the data sources, targets, and data collection schedules.

Table 4

LitTECH Data Sources, Targets, and Data Collection Schedules

Data Sources	Targets	Data Collection Schedules
LitTECH Skill Attainment Survey	Teachers	Beginning and end of teacher's participation
Classroom Profile	Teachers	Beginning and end of teacher's participation
Teacher Interviews	Teachers and Children	End of each school year
Technology Assessment Based on Standards (TABS)	Children	Pre – Post (annually)
Individual Literacy Assessment (ILA)	Children	Pre – Post (annually)
Family Surveys	Children	Beginning and end of child's participation

Teacher data sources. Results related to teachers came from multiple sources, including interviews at the end of each school year, the *LitTECH Skill Attainment Survey*, and the *Classroom Profile*. The *LitTECH Skill Attainment Survey* was 35-item self-report designed to assess teachers' perceptions of their technology-related skills. Teachers ranked various technology skills on a scale from 1-5, with 1 meaning "I can't do this" or "I do not know much about this" to 5 meaning "I can perform all basic functions on my own as well as more advanced functions successfully."

The *Classroom Profile*, a 49-item self-report instrument was designed to assess teacher's implementation of the LitTECH model (i.e., how closely the classroom teacher conformed to the

model). It was divided into four sub-sections: Classroom Facilities, Family Involvement), Materials and Equipment, and LitTECH Curriculum Implementation.

At the end of each school year, treatment teachers were invited to participate in an interview. The goal for the interview was to obtain feedback about the LitTECH training and intervention as well as to gather information regarding teachers' views of the intervention's impact.

Child data sources. Multiple sources were used to collect child data, including annual teacher interviews, a family survey, the *Early Childhood Technology Assessment Based on Standards (TABS),* and the *Individual Literacy Assessment (ILA).* Parents of participating children completed the *LiTECH Family Survey*, a 24-item survey designed to assess children's literacy exposure, skills, and activities at home.

The *Early Childhood Technology Assessment Based on Standards* (*TABS)* was used to access children's technology skills. *TABS*, an observation instrument, was based on the K-12 standards developed from the International Society for Technology in Education and the Illinois Early Learning Standards (2002). The instrument was developed at the Center and tested during the first semester of the project. At that time, it was a 45-item instrument containing six parts: Basic Operations and Concepts; Social, Ethical, and Human Issues; Technology Productivity Tools; Technology Communication Tools; Technology Research Tools; and Technology Problem-solving and Decision-making Tools. Children were rated with a Likert scale from 0 (opportunity not available to child) to 5 (child does independently). Revisions were made because the instrument was ineffective. Revisions included regrouping items so that the instrument was a 28-item instrument, revising the Likert scale from 0 (opportunity not available to child) to 3 (child does independently), and adding a second set of scores under *Section II. Social, Ethical and Human Issues* to collect information on children's behavior related to each of these items when children were not using technology. A 4-page administration manual was added to the *TABS* to help prepare teachers for administering the instrument.

The original *Individual Literacy Assessment* (*ILA)* was a 12-item pre-test/post-test instrument developed for use in the Emergent Literacy Technology Research Study (Hutinger et al., 1998) when no appropriate measures for 3, 4, and 5 year olds with disabilities were found. The instrument was designed to identify and measure changes in literacy skills using elements of existing preschool literacy measures by Dyson (1982), Katims (1991), Strickland (1990), Sulzby (1986, 1988), Teale and Sulzby (1986), and Toomey (1991), thereby ensuring content validity. Items included: holds book in an upright position; follows text from left to right; points to pictures while "reading"; points

to text while "reading"; and turns page at appropriate time. The *ILA* was later revised to 33-items. Pages 25-26 contain more information about *ILA* revisions.

Results

Teacher Results

Multiple data sources were used to determine increases in teacher knowledge and their ability to effectively implement the model. Objectives related to teachers included the following: *(1) As a result of participating in LitTECH training, replication site teachers will acquire strategies to effectively implement the model in their classrooms. (2) Replication site teachers will use information and suggested activities from the LitTECH modules to conduct emergent literacy and technology activities. (3) Replication site staff will report new skills and knowledge developed as a result of LitTECH training and support. (4) Replication site teachers will be better equipped to integrate technology into emergent literacy activities.* All objectives were achieved.

***LitTECH Skill Attainment Survey* results.** At the beginning and end of their participation, treatment and comparison teachers were asked to complete the *LitTECH Skill Attainment Survey*. The total teacher sample for the 3-year study included 57 treatment teachers and 36 comparison teachers. However, full data sets were not received for all teachers; information about the sample for each analysis will be included with the analysis description.

Independent samples t-tests were calculated to determine whether there were any significant differences in comparison ($N = 34$) and treatment ($N = 57$) teachers' technology skills (as measured by the *LitTECH Skill Attainment Survey*) prior to the intervention. The results of these analyses indicated no significant differences at the .01 level for the 35 items compared. One item, which rated teachers' planning strategies for managing student learning in a technology-enhanced environment, was significant at the .05 level ($t = -2.24$, $df = 89$, $p = .028$). On this item, treatment teachers scored higher ($M = 2.44$) as compared to comparison teachers ($M = 3.00$). Overall, these results suggest the two samples reported relatively similar technology skills prior to the intervention.

At the conclusion of the study, independent samples t-tests were again calculated to determine whether there were any significant differences in comparison ($N = 28$) and treatment ($N = 47$) teachers' technology skills. The results of the analyses (see Table 5) indicated significant differences for 11 of the 35 items. These results indicate that treatment teachers learned valuable technology skills that contributed to their effectiveness at applying technology to a diverse range of students.

Treatment teachers did particularly well in the following areas: using technology to manage student learning; using technology that addresses content standards and student technology standards;

designing developmentally appropriate learning opportunities that apply technology-enhanced instructional strategies to support diverse needs of learners; using technology resources to collect and analyze data, interpret results, and communicate findings to improve instructional practice and maximize learning; and applying multiple methods of evaluation to determine students' appropriate use of technology resources for learning, communication, and productivity.

Table 5

Posttest LitTECH Skill Attainment Survey Comparisons

	Mean		*t*	*df*	*p*
	Treatment	Comparison			
Skill with attaching files to email	4.06	3.36	-2.208	73	.030
Use of current technology research in planning strategies	2.83	2.21	-2.256	73	.027
Use of planning for management of technology resources	3.38	2.79	-2.098	73	.039
Use with planning strategies to manage student learning	3.72	2.61	-4.163	73	.000
Use of technology that addresses content standards and student technology standards	3.06	2.18	-3.398	73	.001
Use of technology that addresses diverse needs of students	3.28	2.54	-2.596	73	.011
Use of designing developmentally appropriate learning opportunities that apply technology-enhanced instructional strategies to support the diverse needs of learners	3.43	2.54	-3.312	73	.001
Application of technology to empower learners with diverse backgrounds	3.26	2.57	-2.380	73	.020
Use of technology resources to collect and analyze data, interpret results, and communicate findings to improve instructional practice and maximize student learning	3.23	2.39	-2.736	73	.008
Application of multiple methods of evaluation to determine students appropriate use of technology resources for learning, communication, and productivity	3.00	1.93	-3.418	73	.001
Evaluation and Reflection on professional practice to make informed decisions regarding the use of technology to support student learning	3.04	2.46	-2.021	73	.047

One target set by LitTECH staff was that treatment teachers would report a mean score of 2.8 or higher (on a scale of 5) on 80% of the post LitTECH Skill Attainment Survey items. Treatment teachers' ($N = 47$) mean scores were calculated for each of the 35 items on the post *LitTECH Skill Attainment Survey*. Twenty-eight of the 35 items (80%) received a mean score of 2.8 or higher, meeting the target. Table 6 shows the mean scores for each item.

Table 6

Mean Scores for the Posttest LitTECH Skill Attainment Survey

Skill Attainment Item	Mean Score
Skill with word processing	4.2
Skill with databases	2.9
Skill with spreadsheets	2.6
Skill with email	4.4
Skill with attaching files to email	4.0
Skill with multimedia/presentation software	2.7
Skill with web page browsing	4.3
Skills with web searches	4.3
Skill with troubleshooting software problems	3.0
Skill with troubleshooting hardware problems	2.7
Skill related to file management	3.8
Skill related to using an operating system	2.9
Understanding of technology concepts	3.5
Exposure to technology literature	2.5
Use of technology-enhanced instructional strategies	3.0
Use of current technology research in planning strategies	2.8
Experience in locating technology resources and evaluating	3.0
Use of planning for management of technology resources	3.4
Use with planning strategies to manage student learning	3.7
Use of technology that addresses content standards and student technology standards	3.1
Use of technology that addresses diverse needs of students	3.3
Use of designing developmentally appropriate learning opportunities that apply technology-enhanced instructional strategies to support the diverse needs of learners	3.4
Application of technology to empower learners with diverse backgrounds	3.3
Use of technology to develop student higher order skills and creativity	2.8
Application of technology in assessing student learning of subject matter using a variety of assessment techniques	3.1
Use of technology resources to collect and analyze data, interpret results, and communicate findings to improve instructional practice and maximize student learning	3.2
Application of multiple methods of evaluation to determine students appropriate use of technology resources for learning, communication, and productivity	3.0
Use of technology resources to engage in ongoing professional development and lifelong learning	3.2
Evaluation and Reflection on professional practice to make informed decisions regarding the use of technology to support student learning	3.0
Application of technology to increase productivity	4.0
Use of technology to communicate and collaborate with peers, parents, and the larger community in order to nurture student learning	3.9
Modeling or teaching legal and ethical practice related to technology use	1.8
Identification and use of technology resources that affirm diversity	2.6
Promotion of safe and healthy use of technology resources	2.6
Facilitation of equitable access to technology resources for all students	3.3

***Classroom Profile* results.** At the beginning and end of their participation, treatment and comparison teachers completed the *Classroom Profile*. Independent samples t-tests were calculated to determine if any significant differences in comparison ($N = 32$) and treatment ($N = 57$) teachers' classrooms (as measured by the *Classroom Profile* instrument) existed prior to the intervention. The results of these analyses indicated two items were significant at the .01 level: computer software is accessible to students ($t = -3.00$, $df = 87$, $p = .004$) with treatment teachers ($M = .61$) scoring higher than comparison teachers ($M = .28$); and using the internet to communicate with families about

curriculum activities (t = -2.672, df = 87, p = .009) with treatment teachers (M = .39) scoring higher than comparison teachers (M = .13). Five items were significant at the .05 level: computer monitor is at the children's eye level (t = 2.09, df = 87, p = .039) with comparison teachers (M = 1.00) scoring higher than treatment teachers (M = .88); opportunities for families to be involved in planning curriculum activities (t = -1.948, df = 87, p = .055) with treatment teachers (M = .49) scoring higher than comparison teachers (M = .28); availability of a color printer (t = -2.29, df = 87, p = .025) with treatment teachers (M = .86) scoring higher than comparison teachers (M = .66); software is integrated into projects and/or curriculum (t = -2.29, df = 87, p = .024) with treatment teachers (M = .74) scoring higher than comparison teachers (M = .50); and children access and manage the computer center (t = -2.49, df = 87, p = .015) with treatment teachers (M = .75) scoring higher than comparison teachers (M = .50).

At the study's conclusion, independent samples t-tests were again calculated to determine whether there were any significant differences in comparison (N = 27) and treatment (N = 47) teachers' classrooms. The results of the analyses indicated significant differences for 15 of the 49 items. Table 7 shows these results.

Table 7

Posttest Classroom Profile Comparisons

Items	Mean		*t*	*df*	*p*
	Treatment	Comparison			
Computer is placed in a quiet, well lit, low traffic area	.89	.70	-2.100	72	.039
Computer center contains literacy related materials	.87	.63	-2.512	72	.014
Computer hardware is accessible to students	.68	.44	-2.022	72	.047
Writing materials are accessible to students	1.00	.85	-2.820	72	.006
Conferences are used to facilitate communication between home and school	1.00	.89	-2.391	72	.019
Internet is used to facilitate communication between home and school	.40	.15	-2.345	72	.022
Parent meetings are used to facilitate communication between home and school	.91	.74	-2.058	72	.043
* Using the internet to communicate with families about curriculum activities	.47	.15	-2.892	72	.005
* Availability of a color printer	.91	.74	-2.058	72	.043
Availability of a digital camera	.98	.81	-2.562	72	.012
Access to internet	.83	.63	-1.956	72	.054
* Software is integrated into projects and/or curriculum	.85	.63	-2.223	72	.029
Children are encouraged to relate software to experiences	.70	.41	-2.561	72	.013
Adult questions are phrased to encourage oral language	1.00	.89	-2.391	72	.019
* Children access and manage computer center	.83	.59	-2.298	72	.024

* Note: These items were significantly different at pre and thus should be interpreted with caution.

Results of the *Classroom Profile* comparisons suggest that the treatment teachers implemented important components of the LitTECH curriculum into their classrooms. To determine the literacy implementation score for each teacher ($N = 47$), a total score was calculated for the 12 literacy-related items for each treatment teacher. Table 8 shows the 12 items. Total scores could range from 0-12. Sixty-two percent of treatment teachers ($n = 29$) reported a score of 9 or higher on these 12 items.

Table 8

Classroom Profile Curriculum Implementation Items

Item 31	Ongoing activities relate to children's experiences.
Item 32	Software is integrated into projects and/or curriculum.
Item 33	Technology is used to support literacy.
Item 35	Children use the computer microphone.
Item 36	Children are encouraged to relate software to experience.
Item 39	Software is used to promote and support oral language.
Item 40	Children use sign up sheet to manage computer use.
Item 42	Software is used to promote/support drawing and writing.
Item 44	Children access and manage the computer center.
Item 46	Books are used to accompany interactive software.
Item 47	Software is used to promote and support reading.
Item 49	Adults interact with discussion board.

To determine the technology score for each teacher, a total score was calculated for the eight technology-related items for each treatment teacher. Table 9 shows the eight items. Total scores could range from 0 to 8. Seventy-two percent of treatment teachers ($n = 34$) reported a score of 6 or higher on these eight items.

Table 9

Classroom Profile Technology-Related Items

Item 2	Computer is placed in a quiet, well lit, low traffic area.
Item 3	Computer center contains literacy related materials.
Item 4	Computer monitor is at the children's eye level.
Item 5	Multiple chairs are located in the technology center.
Item 6	Storage area for computer materials is located nearby.
Item 7	Computer software is accessible to children.
Item 8	Computer hardware is accessible to children.
Item 9	Keyboard is accessible to children.

Teacher Interview results. Eleven teachers in Year 1, 26 teachers in Year 2, and 17 teachers in Year 3 agreed to the end-of-the-year interview. Table 10 summarizes teachers' reflections—both positive and negative—to changes, new practices, implementation, use of the training materials, and use of support services.

Table 10

LitTECH Teacher Interview Summary

	Year 1 (*N*=11)		Year 2 (*N*=26)		Year 3 (*N*=17)	
Teacher Responses	**Positive Comments**	**Expressed Barriers**	**Positive Comments**	**Expressed Barriers**	**Positive Comments**	**Expressed Barriers**
Commented about changes	*n*=9 , 82%	*n*=2, 18%	*n*=17, 65%	*n*=9, 35%	*n*=11. 65%	*n*=5, 29% No response (NR) *n*=1, 06%
Implemented new practices	*n*=10, 91%	*n*=1, 09%	*n*=21, 81%	*n*=3, 11% NR *n*=2, 8%	*n*=16, 94%	NR *n*=1, 06%
Implemented LitTECH	*n*=9, 82%	*n*=2, 18%	*n*=17, 65%	*n*=9, 35%	*n*=10, 59%	*n*=7, 41%
Used LitTECH manual	*n*=8, 73%	*n*=2, 18%	*n*=16, 62%	*n*=7, 27% NR *n*=3, 11%	*n*=9, 53%	*n*=3, 18% NR *n*=5, 29%
Commented on effectiveness of LitTECH support services	*n*=5, 45%	*n*=3, 27%	*n*=4, 15% Services not needed *n*=19, 73%	N/A *n*=2, 8% NR *n*=1, 4%	*n*=2, 12% Services not needed *n*=13, 76%	NR *n*=2, 12%

Across the 3 years, over 80 percent of treatment teachers who responded (91%, *n*=10 in Year 1, 81%, *n*=21 in Year 2, and 94%, *n*=16 in Year 3) reported that they implemented new technology practices in the classroom. The following examples from the interviews illustrate the types of practices implemented:

- *My whole approach at the computer center has changed. I now see the computer center as I do other centers in the classroom. I use a choice board for selecting software, place props and books related to software in the computer center, give children NO time limits while playing with software, and allow the children to manipulate the software.*
- *We use the computer for curriculum extension through software activities. The students are using web sites that provide a wider range of activities for them to use; creative art and pictures are encouraged; and teachers are able to assist students in creating slide shows of their pictures and pictures of classroom adventures.*
- *I stopped using a timer to manage turn taking and started using a sign-up sheet encouraging language.*
- *The kids are using a sign-up sheet to use the computer. They are practicing writing their name and learning that writing carries meaning and has a purpose.*
- *I like to prepare extensions for storybooks we are reading so that during Group Time the students can complete sequencing, matching, and retelling activities.*

Child Results

Multiple data sources were used to determine the impact of the LitTECH model on children. Objectives related to teachers included the following: *(1) Teachers and families indicate positive results for children from LitTECH activities used in the classroom and at home. (2) Children with disabilities can access literacy materials and participate in literacy activities. (3) Children at treatment sites have increased access to emergent literacy and technology activities and make greater gains in concepts of print, oral communication, emergent writing skills, problems solving skills, listening skills, and social interaction.* All objectives were achieved.

***Early Childhood Technology Assessment Based on Standards (TABS)* Results**

The *TABS* was used in Year 1 then revised, as explained on page 17. For that reason, only Years 2 and 3 data are reported in the following section.

At the beginning and end of each participation cycle, treatment and comparison teachers used the *TABS* to collect data on children's technology skills. Independent samples t-tests were calculated to determine if any significant differences in comparison and treatment children's technology skills existed prior to the intervention. Results indicated significant differences for two of the sections on the *TABS:* knowledge of basic operations and concepts (t = -3.437, df = 442, p = .001), with treatment children (M = 9.59) scoring higher than comparison children (M = 5.10) and social, ethical, and human issues (t = -5.520, df = 445 , p = .000), with treatment children (M = 19.52) scoring higher than comparison children (M = 10.62).

To determine the changes in children's technology skills, items on the *TABS* were analyzed for treatment and comparison children. At the end of the study, paired samples t-tests, comparing the pretest scores to the posttest scores, were calculated for both treatment and comparison children to analyze changes over time. Table 11 shows the results of these analyses. For treatment children, statistical significance was found for six of the seven sections. For comparison children, statistical significance was found for three of the seven sections. These findings suggest that treatment children saw greater gains in technology skills particularly in the areas of basic operations and concepts (which included such tasks as initiating the process for launching software, launching and navigating software, saving documents, executing a print command, troubleshooting hardware and/or software problems, and exiting a program), using technology productivity tools (which included such tasks as using software for productivity, using hardware for productivity, and connecting productivity hardware devices to the computer), and using technology problem-solving and decision-making tools (which included the task of using technology to make informed decisions).

Table 11

Posttest TABS Comparisons

	N	Pretest		Posttest		*t*	*p*
		M	*SD*	*M*	*SD*		
Treatment Children							
Basic operations and concepts	390	9.56	5.906	12.42	6.633	-11.803	.000
Social, ethical and human issues (when using technology)	392	19.39	7.203	22.78	7.227	-11.880	.000
Social, ethical and human issues (when not using technology)	324	22.64	6.062	24.53	6.057	-7.457	.000
Technology productivity tools	326	2.33	1.930	2.72	2.737	-2.589	.010
Technology communication tools	362	.81	.743	.89	1.137	-1.297	.196
Technology research tools	379	1.01	1.469	1.30	1.667	-3.556	.000
Technology problem-solving and decision-making tools	380	.89	1.456	1.08	1.559	-2.504	.013
Comparison Children							
Basic operations and concepts	21	5.10	3.740	5.52	4.578	-.750	.462
Social, ethical and human issues (when using technology)	21	10.62	9.091	20.29	7.397	-3.344	.003
Social, ethical and human issues (when not using technology)	21	22.14	5.756	24.38	6.062	-3.278	.004
Technology productivity tools	11	2.00	.000	2.00	.000	---	---
Technology communication tools	21	1.00	.000	.90	.301	1.451	.162
Technology research tools	11	.45	.522	.82	.982	-2.390	.038
Technology problem-solving and decision-making tools	11	1.55	1.864	1.82	2.136	-1.936	.082

***Individual Literacy Assessment (ILA)* results.** At the beginning and end of each participation cycle, treatment and comparison teachers also collected data on children's emergent literacy skills using the *ILA*. In Years 1 and 2, a 33-item *ILA* instrument described on pages 17-18 was used to assess changes in children's emergent literacy skills. During those 2 years, data were collected for 581 treatment children. However, only 393 of those children had complete *ILA* data sets. Therefore, the following information is based upon 393 treatment children.

A difference score was calculated for each of the 393 children by subtracting each child's pre *ILA* total score from his/her post *ILA* total score. Seventy-six percent of the children ($N = 300$) showed an increase of 1 or more points from pretest to posttest (range = 1 to 16). Ten percent of the children ($N = 29$) showed no increase and 16 percent ($N = 64$) showed a decline. In finding such results, concerns were raised about the 64 children who showed a decline. It seemed illogical that so many children would have *fewer* skills at the posttest.

As a result, the *ILA* was revised to ensure the instrument better reflected children's literacy growth. The 33-item version could actually end up awarding fewer points for higher levels of literacy skills (e.g., repeating a story from memory compared to looking at the pictures of a story), but the revised *ILA* eliminated that problem. The revised *ILA* consists of 24 items in four parts. Part 1

contains six items addressing a child's interactions with books and other print materials. Part II contains eight items addressing children's memory skills and behaviors when a book is read to them. Part III contains seven items addressing a child's behaviors as the child handles and "reads" (i.e., acts as if reading) a book, and Part IV contains three items addressing the stages of mark-making and writing. As part of the revision, criteria based upon a number of sources (Dodge & Colker, 1992, Fountas & Pinnell, 1996; Horning, 1997; Jalongo & Ribblett, 1997; Morrow, 1997b; Project ELIPSS, 1996; Tomlinson & Lynch-Brown, 1999) were established for selecting books to use with the *ILA*. In addition, a seven-page administration manual and a training DVD were developed to prepare teachers to administer the *ILA*. The manual includes instructions, procedures, and criteria for scoring each part of the *ILA*.

The revised *ILA* was used during Year 3. In Year 3, data were collected for 386 treatment children. However, only 206 of those children had complete *ILA* data sets. Therefore, the following information is based upon 206 children. A difference score was calculated for each of the 206 children by subtracting each child's pre *ILA* total score from his/her post *ILA* total score. Eighty-four percent of the children ($N = 173$) showed an increase of 1 or more points from pretest to posttest (range = 1 to 18). Three percent of the children ($N = 6$) showed no increase and 13 percent ($N = 27$) showed a decline. While the number of children who showed a decline decreased, additional work on the *ILA* will continue to ensure the data collection process is accurate.

Based upon these results, further analysis of children's specific emergent literacy skills was warranted. Independent samples t-tests for Years 1 and 2 were calculated to determine whether there were any significant differences in comparison and treatment children's emergent literacy skills prior to the intervention. The eight factors used were: (1) child interacts with book and print materials, (2) child demonstrates understanding of story, (3) child orients book appropriately for reading, (4) child demonstrates literacy behaviors in response to pictures, (5) child demonstrates literacy behaviors in response to print, (6) child demonstrates early writing behaviors, (7) child attempts to communicate using letters, and (8) child uses inventive and conventional spellings. The results of these analyses indicated significant differences for three of the factors: factor 5 ($t = 2.615$, $df = 435$, $p = .009$) with comparison children ($M = .63$) outperforming treatment children ($M = .36$), factor 6 ($t = 3.126$, $df = 436$, $p = .002$) with comparison children ($M = 2.20$) outperforming treatment children ($M = 1.88$), and factor 7 ($t = 2.722$, $df = 436$, $p = .007$) with comparison children ($M = 1.76$) outperforming treatment children ($M = 1.44$).

Independent samples t-tests for Year 3 were also calculated to determine whether there were

any significant differences in comparison and treatment children's emergent literacy skills prior to the intervention. The five factors used were: (1) interacting with book and print materials (e.g., recognizing environmental print, asking for stories to be read, making predictions, and independently selecting a book); (2) demonstrating an understanding of story (e.g., answering questions about characters, actions, setting, and beginning, middle, and end of story); (3) book handling skills (e.g., holding book right side up, turning pages left to right); (4) responding to pictures and print (e.g., pointing to pictures, naming or labeling items in pictures, following print from top to bottom and left to right); and (5) demonstrating emergent writing behaviors.

The results of these analyses indicated significant differences for one factor: factor 5 (t = 5.064, df = 240, p = .000) with comparison children (M = 5.84) outperforming treatment children (M = 3.24).

At the end of the study, paired samples t-tests, comparing pretest scores to posttest scores, were calculated for both treatment and comparison children to analyze changes over time. Table 12 shows the results of these analyses. For Years 1 and 2 treatment children, statistical significance was found for all eight factors. For Years 1 and 2 comparison children, statistical significance was found for only three of the eight factors. For treatment children in Year 3, statistical significance was found for all five factors, while for Year 3 comparison children statistical significance was found for three of the five factors. These findings suggest that treatment children saw greater gains in various emergent literacy skills than their comparison counterparts.

Table 12

Posttest ILA Comparisons

Items	N	Pretest		Posttest		t	p
		M	SD	M	SD		
Treatment Children Years 1 & 2							
Child interacts with book and print materials	331	1.95	1.101	2.54	.813	-11.845	.000
Child demonstrates understanding of story	330	3.65	1.477	4.32	.945	-10.563	.000
Child orients book appropriately for reading	328	3.88	1.075	4.39	.842	-9.559	.000
Child demonstrates literacy behaviors in response to pictures	330	2.66	1.469	3.32	1.432	-8.335	.000
Child demonstrates literacy behaviors in response to print	329	.37	.878	.83	1.226	-7.647	.000
Child demonstrates early writing behaviors	331	1.88	.820	2.13	.710	-5.398	.000
Child attempts to communicate using letters	330	1.42	.949	1.57	1.030	-2.441	.015
Child uses inventive and conventional spellings	331	.63	.992	1.32	1.276	-11.607	.000
Comparison Children Years 1 & 2							
Child interacts with book and print materials	76	1.95	1.221	2.17	1.159	-2.315	.023
Child demonstrates understanding of story	73	3.88	1.572	4.03	1.572	-1.468	.146
Child orients book appropriately for reading	75	4.05	1.138	4.21	.990	-1.719	.090
Child demonstrates literacy behaviors in response to pictures	74	3.00	1.499	3.24	1.524	-2.029	.046
Child demonstrates literacy behaviors in response to print	75	.69	.930	.91	1.327	-1.569	.121
Child demonstrates early writing behaviors	75	2.20	.959	2.20	.838	000	1.00
Child attempts to communicate using letters	75	1.79	1.082	1.60	1.185	1.262	.211
Child uses inventive and conventional spellings	75	.75	.988	1.05	1.012	-3.054	.003
Treatment Children Year 3							
Child interacts with book and print materials	189	4.13	1.750	4.93	1.455	-7.311	.000
Child demonstrates understanding of story	189	5.10	2.424	6.12	2.366	-7.426	.000
Child demonstrates book handling skills	189	3.02	1.436	3.72	1.106	-6.737	.000
Child demonstrates literacy behaviors in response to pictures and print	189	1.85	1.285	2.34	1.467	-5.692	.000
Child demonstrates writing behaviors	189	3.31	2.332	5.07	3.200	-9.326	.000
Comparison Children Year 3							
Child interacts with book and print materials	18	4.11	1.745	5.39	1.378	-2.945	.009
Child demonstrates understanding of story	18	5.17	2.333	7.17	2.036	-4.067	.001
Child demonstrates book handling skills	18	3.17	.985	3.44	1.149	-.893	.384
Child demonstrates literacy behaviors in response to pictures and print	18	2.94	1.056	3.11	1.530	-.458	.653
Child demonstrates writing behaviors	18	5.78	3.001	7.83	3.552	-3.325	.004

Teacher interview results. In addition to the *TABS* and *ILA*, child data was obtained from the teacher interview. Table 13 summarizes treatment teacher responses for each of the 3 years, showing numbers and percentages of teachers who indicated positive results as a result of or barriers to technology implementation in their classrooms. More treatment teachers reported positive results than barriers in each of the 3 years.

Table 13

Teacher Reports of Positive Changes Seen in Children and Barriers Related to Technology Implementation

	Year 1 (*N*=11)		**Year 2 (*N*=26)**		**Year 3 (*N*=17)**	
	Positive Changes	**Barriers to Change**	**Positive Changes**	**Barriers to Change**	**Positive Changes**	**Barriers to Change**
Positive literacy behaviors	*n*=11 100%	*n*=0 00%	*n*=25 96%	*n*=1 04%	*n*=15 88%	No response *n*=2 12%
Positive child results	*n*=11 100%	*n*=0 00%	*n*=22 85%	*n*=3, 11% No response *n*=1, 04%	*n*=14 82%	*n*=1, 06% No response *n*=2, 12%
Improved child achievement	*n*=7 64%	*n*=3 27%	*n*=17 65%	*n*=7, 27% No response *n*=2, 08%	*n*=11 65%	*n*=4, 23% No response *n*=2, 12%
See differences from previous groups	*n*=8 73%	*n*=2 18%	*n*=17 66%	*n*=7, 27% No response *n*=2, 07%	*n*=12 71%	*n*=3, 18% No response *n*=2, 12%

Representative comments from teachers included:

- *The children are becoming very active at the computer. They love to sign in and have their friends join them.*
- *Verbal interaction at the computer is continuous, much to my surprise. The students like to help each other with what is going on and interpret the directions. There is much descriptive language being shared. They like to put in their own information about their name so that the activities reflect them and then to take printouts home to show their family. We have been labeling more of their drawings with them matching the letters in the words that they want.*
- *[Computer use] supports their literacy behaviors because: (1) they sign up for a turn, (2) they use programs with literacy elements, and (3) they make books using the computer.*
- *The children are using picture books that relate to the software more and are beginning to understand the concept of reading left to right.*
- *They work on labeling common objects, patterning, counting, letter recognition, and some sorting and sequencing.*
- *The computer allows ESL students to participate with English speakers in classroom activities that are not language based. Reinforces turn-taking and sharing behaviors.*

Family survey results. Information from the *LitTECH Family Survey* also provided information on children's progress. At the beginning and end of their children's participation, parents were asked to complete the *LiTECH Family Survey*.

Pre *LitTECH Family Surveys* were received for 627 children (although not all surveys were completed in their entirety). These surveys provided a wealth of literacy demographic information.

Eighty percent of parents (n = 498 out of 620 reporting) reported reading to their children everyday. Eighty-five percent of parents (n = 533 out of 625 reporting) reported having 21 or more books in their home. The majority of these books were owned by the families, although many parents also checked out books from the school and/or public library. Seventy-five percent of parents (n = 469 out of 627 reporting) reported sharing books with their children prior to age one, and 77% of parents (n = 483 out of 626 reporting) reported reading to their child either every day or three or more times a week.

The post *LitTECH Family Survey* sent to comparison families consisted of the original 24 items, while the version sent to treatment families included those items plus three additional items designed to provide feedback on families' LitTECH participation. Seven hundred ninety-nine children served as treatment participants in the 3-year study. Post *Family Surveys* were received for 298 of the children. Therefore, the following information is based upon 298 children.

Item 25 of the *LiTECH Family Survey* asked, "How have family members been involved in the interactive curriculum?" Parents reported the following: 162 parents (54%) reported receiving information about technology activities; 21 parents (7%) reported assisting in interactive technology activities; and 11 parents (4%) reported contributing materials and resources. This data clearly reveals that parents' participation was largely passive.

Item 26 of the *LiTECH Family Survey* asked, "Do you think your child benefited from involvement with the literacy technology activities?" and "If so, how did your child benefit?" The vast majority of parents (n = 229) reported that the program provided benefits to their children. The benefits reported included: communication skills (n = 136); language development (n = 155); listening skills (n = 149); reading skills (n = 127); and writing skills (n = 106).

Item 27 of the *LiTECH Family Survey* asked, "Do you feel you have gained knowledge and/or skills from being involved in literacy activities with your child?" and "If so, what have you gained?" Over half of the parents (n = 170) reported the program benefited them personally. The benefits reported included: knowledge of how my child acquires emergent literacy skills (n = 93); knowledge of how technology helps my child gain emergent literacy skills (n = 92); knowledge of how technology is used as a tool to communicate with my child (n = 75); knowledge of computer programs and activities for my child (n = 78); and understanding of what my child does with technology (n = 71).

To determine the changes in children's literacy skills (as reported by parents/guardians) due to the LitTECH intervention, items on the *LitTECH Family Survey* were analyzed for comparison and

treatment children. Independent samples t-tests were calculated to determine whether there were any significant differences in comparison and treatment children's literacy skills prior to the intervention. The results of these analyses indicated no significant differences at the .01 level for the 14 items compared. See Table 14. One item, which rated children's prediction skills, was significant at the .05 level ($t = 2.04$, $df = 619$, $p = .042$). Comparison children scored higher on this item ($M = 1.94$) than did treatment children ($M = 1.77$). Overall, these results suggest the two samples were relatively similar prior to the intervention.

Table 14

Fourteen LitTECH Family Survey Items Compared Pre- and Posttest

Item 6	How often does your child retell a story by looking at pictures?
Item 7	How often does your child retell a story by memorizing the words?
Item 8	How often does your child ask questions about a story while you are reading?
Item 9	How often does your child follow the story by pointing to words or pictures?
Item 10	How often does your child request an adult to create signs or symbols for their play activity?
Item 11	How often does your child look at print and ask, "Where does it say this?" or "What does this say?"
Item 12	How often does your child predict what will happen next in the story?
Item 13	How often does your child tell stories that have a beginning, middle, and end?
Item 14	How often does your child spend time looking at books independently?
Item 15	How often does your child read signs such as stop, brand names like McDonalds, and other familiar print?
Item 16	How many letters of the alphabet can your child name?
Item 17	Can your child recognize and sight-read words in a favorite book?
Item 18	How often does your child make marks that look like letters?
Item 19	How many letters of the alphabet can your child print?

At the end of the study, paired samples t-tests, comparing the pretest scores to the posttest scores, were calculated for both the treatment and comparison children to analyze the changes over time. Table 15 shows the results of these analyses. For treatment children, statistical significance was found for all 14 items. Effect sizes ranged from .12 to .72. For comparison children, statistical significance was found for seven of the 14 items. Effect sizes ranged from -.09 to .42. While it may be argued that the seven items that were significant for both treatment and comparison children could be explained by development, since both groups showed an increase, it should be noted that the effect sizes were greater for the treatment children in all cases except one.

Table 15

Pre- and Posttest LitTECH Family Survey Comparisons of Fourteen Items

		Pretest Mean	Posttest Mean	*t*	*p*	Effect Size	Confidence Interval
Item 6	Treatment	2.21	2.45	-6.79	.000	.37	(.21, .53)
	Comparison	2.25	2.15	1.35	.182	-.13	(-.49, .22)
Item 7	Treatment	1.70	1.97	-6.61	.000	.38	(.22, .54)
	Comparison	1.56	1.79	-2.91	.005	.35	(-.01, .70)
Item 8	Treatment	2.33	2.50	-4.29	.000	.24	(.08, .40)
	Comparison	2.26	2.39	-2.05	.045	.16	(-.19, .52)
Item 9	Treatment	2.24	2.41	-4.15	.000	.24	(.08, .40)
	Comparison	2.23	2.23	0	1.00	0	(-.35, .35)
Item 10	Treatment	1.59	1.81	-5.29	.000	.33	(.17, 49)
	Comparison	1.59	1.69	-.948	.347	.15	(-.21, .50)
Item 11	Treatment	1.96	2.36	-9.07	.000	.51	(.35, .67)
	Comparison	1.95	2.20	-2.50	.015	.31	(-.05, .66)
Item 12	Treatment	1.80	2.10	-7.10	.000	.42	(.26, .58)
	Comparison	1.87	2.00	-1.59	.117	.17	(-.19, .53)
Item 13	Treatment	1.85	2.12	-7.08	.000	.36	(.20, .52)
	Comparison	1.72	2.02	-4.66	.000	.41	(.05, .76)
Item 14	Treatment	2.57	2.63	-2.05	.041	.12	(-.04, .28)
	Comparison	2.59	2.54	.65	.517	-.09	(-.45, .26)
Item 15	Treatment	2.81	3.24	-8.26	.000	.45	(.29, .61)
	Comparison	2.74	2.98	-2.58	.012	.22	(-.14, .57)
Item 16	Treatment	3.55	4.53	-12.50	.000	.56	(.39, .73)
	Comparison	3.62	3.98	-1.54	.128	.16	(-.20, .52)
Item 17	Treatment	1.56	1.94	-8.32	.000	.46	(.30, .63)
	Comparison	1.50	1.65	-1.76	.083	.20	(-.16, .55)
Item 18	Treatment	2.31	2.92	-11.90	.000	.59	(.42, .75)
	Comparison	2.33	2.62	-2.61	.011	.27	(-.09, .63)
Item 19	Treatment	2.46	3.67	-14.99	.000	.72	(.56, .89)
	Comparison	2.44	3.15	-5.22	.000	.42	(.06, .78)

Barriers to Model Implementation

LitTECH Outreach involved a wide geographical area, with sites in two states. Sites included small rural school districts and large districts in well-populated urban areas. District size and layers of administration in the large districts caused difficulties which (1) impeded teachers' abilities to implement the model and (2) hampered success in collecting data from these teachers. Prior to providing LitTECH training to teachers, LitTECH directors were assured of "buy in" from the administration of all school districts where the model was replicated. However, changes in school administrators, in a district's priorities from year to year, and in districts' resource allocations had negative impacts on replication. These changes impacted the level of support offered to the teachers, generally in monetary support of classroom technology, but in particular in the amount of administrative support for model implementation. For example, larger districts had stringent regulations regarding use of classroom hardware and software. These regulations, in place primarily

for middle and high school students, were passed down to the early childhood centers and made it impossible for teachers to use and install software, download digital pictures, and customize programs for children with special needs. Interestingly (and frustratingly), administrators who had fully supported teachers by allowing them release time for LitTECH training would not support lifting the restrictions so these preschool teachers could appropriately implement the LitTECH model by using software recommended during training.

The second problem related to data collection and was again created by lack of administrative support. Without administrative support, teachers were frustrated in their model implementation plans. Unable to implement the model, they also ignored requests for submitting data they agreed to collect. Administrators who agreed to gather and submit data from comparison teachers did not follow through on their agreements. As a result, we had incomplete data sets.

Impact

Positive Outcomes for Teachers and Children

Data collected during the 3-year LitTECH project demonstrated positive results for treatment classroom teachers and children. Treatment teachers learned to implement key components of the LitTECH model curriculum, including creating appropriate classroom computer center environments. They also integrated technology tools and software into the classroom curriculum and used technology to facilitate communication between home and school.

Treatment teachers learned valuable technology skills that allowed them to effectively implement technology activities with a diverse range of students. Over the course of their involvement with LitTECH, these teachers became adept at

(1) managing student learning with technology tools;

(2) using technology to address content and student technology standards;

(3) designing developmentally appropriate learning opportunities that apply technology-enhanced instructional strategies to support diverse needs of learners;

(4) using technology resources to collect and analyze data, interpret results, and communicate findings to improve instructional practice and maximize learning; and

(5) applying multiple methods of evaluation to determine students' appropriate use of technology resources for learning, communication, and productivity.

Treatment children saw greater gains in emergent literacy skills than their comparison counterparts. These skills included

(1) interacting with book and print materials (e.g., recognizing environmental print, asking for

stories to be read, making predictions, independently selecting a book);

(2) demonstrating an understanding of story (e.g., answering questions about characters, actions, setting, and beginning, middle, and end of story);

(3) book handling skills (e.g., holding book right side up, turning pages left to right);

(4) responding to pictures and print (e.g., pointing to pictures, naming or labeling items in pictures, following print from top to bottom and left to right); and

(5) demonstrating emergent writing behaviors.

Treatment children also had greater gains than comparison classroom children in technology skills in the following areas:

(1) basic operations and concepts (which included such tasks as launching and navigating software, saving documents, executing a print command, and exiting a program),

(2) using technology productivity tools (which included such tasks as using software for productivity and connecting productivity hardware devices to the computer), and

(3) using technology problem-solving and decision-making tools.

Parents reported that involvement in the literacy technology program provided benefits to their children. Reported benefits included: improved language development, as well as improved communication, listening, reading, and writing skills.

Products

The STARNET Video Magazine, *From Drawing to Writing: How Technology Supports the Process,* featured the LitTECH staff and was originally video streamed on the STARNET website in January 2006. The program is currently available on STARNET's online video archives <www.wiu.edu/starnet/training/apples/index.php> and on DVD or VHS from STARNET Regions I and III, 32 Horrabin Hall, Western Illinois University, Macomb, IL 61455.

eMERGing Literacy and Technology: Working Together, the Center's literacy and technology curriculum, was revised as part of the LitTECH workscope and completed in 2008. The curriculum contains activities for 49 software programs and features integration ideas for art, blocks and manipulatives, construction, cooking and snacks, dramatic play, group and individual story experiences, music and movement, outdoor play and motor activities, literacy, science and math, and sensory activities related to software content. In addition, suggestions are given for literature, additional supporting software, websites related to software content; for activities outside the classroom; and for family involvement activities. The curriculum is available from the Center for Best Practices in Early Childhood and can be ordered online at

<www.wiu.edu/thecenter/products_print.php>.

Model Replication

If a teacher is interested in replicating the model, it is recommended that administrative support for implementation be established and maintained, that a technology budget be established to purchase quality hardware and software for implementing the model, that the teacher be well trained on model implementation, and that the teacher then closely follow model implementation protocols. Implementing the model successfully requires a commitment from *both* teacher *and* administration, but it is a commitment that results in positive outcomes for children and teachers.

The model can be replicated using the *LitTECH ToolKit*, which was constructed as a "Train the Trainers" tool. The *ToolKit* contains the *eMERGing Literacy and Technology: Working Together, Fourth Edition* curriculum; the *eMERGing Literacy and Technology: Working Together Resource Guide*, containing agenda for each of the training modules; and five DVDs that can be used during training: *Supporting Early Childhood Curriculum with Technology, LitTECH Interactive Presents—The Beginning of Literacy, Tools of the Trade—Early Childhood Software, A Guide to Selecting Software for Young Children,* and *Your Preschool Classroom Computer Center, How Does It Measure Up?*. The *ToolKit* is available from the Center for Best Practices in Early Childhood at Western Illinois University, Macomb, Illinois. Ordering information is online at <www.wiu.edu/thecenter/products_print.php>.

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