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ABSTRACT

This report presents findings of a 3-year study (1995-1998) of the effects of a comprehensive system of technology services to young children with mild to severe disabilities. The system's model incorporated: (1) on-going training, follow-up and technical support for teachers, and an on-site technology support team; (2) team-based technology assessment for children with moderate to severe disabilities; (3) technology integration into the classroom curriculum; and (4) transition into public school programs. The project's major findings indicated positive outcomes for children, increased technology skills among teachers, efficacy of the on-site technology teams, and conditions that promoted maintenance of the system after completion of the funding cycle. Following an executive summary and introduction, the description of the project details components of the Early Childhood Comprehensive Technology System, methodology for accomplishing goals, and problems and their solutions. The following section summarizes results relevant to teacher outcomes, child outcomes, policy, and maintenance of a comprehensive technology system. Concluding sections address lessons learned, implications, and recommendations. An appendix summarizes principles related to establishing and maintaining an effective early childhood comprehensive technology system. A closed-captioned videotape accompanies the report. (Contains 32 references.) (DB)

Final Report

Benefits of a Comprehensive Technology System in an Early Childhood Setting: Results of a Three-year Study

by Patricia Hutinger, Joyce Johanson, and Robert Rippey

Technology, Educational Media, and Materials for Individuals
with Disabilities Program

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Benefits of a Comprehensive Technology System in an Early Childhood Setting: Results of a Three-year Study

by Patricia Hutinger, Joyce Johanson, and Robert Rippey

Executive Summary

The Early Childhood Comprehensive Technology System (Project ECCTS), a 3-year collaborative research study, was conducted by Macomb Projects (now the Center for Best Practices in Early Childhood) in the College of Education and Human Services at Western Illinois University (WIU) in Macomb, Illinois, and Just Kids Early Childhood Learning Center in Middle Island, New York. The project, which examined the effects of a comprehensive system on technology services to young children with disabilities, began September 1, 1995. The major goal of the study was to advance the availability, quality, use and effectiveness of technology in addressing the practical problem of improving technology access for 3- and 4-year-olds with mild to severe disabilities.

The comprehensive technology system was based on a confluence of four components of nationally-recognized demonstration models and peer-reviewed outreach models funded by the Early Education Program for Children with Disabilities (EEPCD) in the U.S. Department of Education. The system's models incorporated (1) on-going training, follow-up and technical support for teachers and an on-site Technology Support Team (Tech Team); (2) team-based technology assessment for children with moderate to severe disabilities; (3) technology integration into the classroom curriculum; and (4) transition into public school kindergartens and other programs. The project's major findings point to positive outcomes for children, to increased technology skills among teachers, to the efficacy of an on-site Tech Team, and to conditions that promoted maintenance of the system after the funding cycle was completed.

Introduction

The legislative requirements, the needs of children and families, and the critical technology needs of schools and agencies emphasize the importance of providing tested, effective, comprehensive technology services. The Individuals with Disabilities Education Act Amendments of 1997, P.L. 105-17 (IDEA 97) make it clear that the educational system must include technology and make dramatic and timely changes so *all* children can keep pace with technological and societal changes. The term '*all*' includes children in early intervention programs from infancy through preschool. Computer applications and adaptive devices, the focus of ECCTS, provided a set of components to insure this opportunity. Computer hardware, interactive software, adaptive devices, switches and other alternative input devices, and related off-computer activities implemented by ECCTS gave young children with mild to severe disabilities a set of tools to equalize learning opportunities across developmental domains and curricular content—strategies that led to access to activities in the general curriculum.

ECCTS originated when the need for a comprehensive system was repeatedly emphasized in the results of a modified longitudinal study of benefits and barriers to young children's technology use (Hutinger et al, 1994) and in Macomb Projects' practical experience gained from working with families, agencies, and schools in nationally-recognized projects for over 20 years. Data from model demonstration and outreach replication projects demonstrated the effectiveness of each project for children and families. However, the projects had never been combined to test an entire system. The test came when Macomb Projects and Just Kids Early Childhood Learning Center collaborated to design and implement ECCTS and to study the system's effectiveness. Macomb Projects managed and coordinated training, staff development, data storage, analysis and summaries. Just Kids managed and coordinated use of the ECCTS components with children, families, and staff; collected qualitative and quantitative data; provided ongoing staff development and technical assistance; and conducted focus groups relating to implementation and policy. Both organizations were involved in data analysis, validation, and dissemination activities.

Project Description

Components of the Early Childhood Comprehensive Technology System

The ECCTS components were based on tested, effective early childhood models developed, evaluated, and replicated through funding from the U.S. Department of Education's Early Education Program for Children with Disabilities (EEPCD). Each model produced procedures and materials; worked with children, families, and staff; and collected positive efficacy data evaluated by peer review and the funding agency. Procedures and materials used in the models underwent continuous updating to reflect current technology advances, legislation, and societal changes. Basing a comprehensive early childhood technology system on tested model components provided advantages that included immediate start-up, minimal investment of time in materials and procedure development, and a foundation for modifications. Five of the models were developed by Macomb Projects while the sixth was developed by a group in Kansas. See Figure 1.

Figure 1. Components of the Early Childhood Comprehensive Technology System

Components	Early Childhood Projects on which the Components were Based	Projects Developed By
Training and Staff Development for Just Kids Teachers and Tech Team	• Activating Children Through Technology Outreach (ACTT Outreach) • Technology Inservice Project (TIP) • Technology Team Assessment Process Outreach (TTAP Outreach)	Macomb Projects Western Illinois University Macomb, IL 61455
Technology Assessment of Children with Moderate to Severe Disabilities	• Technology Team Assessment Process (Project TTAP)	Macomb Projects Western Illinois University Macomb, IL 61455
Curriculum Integration of Computers and Software into Daily Activity and Experience	• Activating Children Through Technology Outreach (ACTT)	Macomb Projects Western Illinois University Macomb, IL 61455
Transition into Public School Kindergartens and Other Programs	• Bridging Early Services Transition Project (BEST)	Associated Colleges of Central Kansas McPherson, KS 67460

Elements of best practices were incorporated into each model's design. Principles of adult learning (Knowles, 1978, 1980; Krupp, 1989) formed the basis for the training models, while the components that encompassed assessment, curriculum, and transition were intentionally designed around recognized best practices for young children as recommended by both the National Association for the Education of Young Children (NAEYC) and the Division of Early Childhood (DEC). A description of the models and their role in ECCTS follows.

Inservice training. The models for delivering staff technology training were provided by Activating Children Through Technology (ACTT) Outreach (Hutinger, 1993a, 1996) and the Technology Inservice Project (TIP) (Hutinger, 1995). Experienced technology trainers from Macomb Projects trained teaching staff and an on-site Tech Team at Just Kids. That Team, in turn, eventually provided training and support to Just Kids' teachers, therapists, and families. The effectiveness of the Tech Team was a factor that led to the agency continuing the program after federal funding ceased.

Curriculum integration. The model for curriculum integration throughout classroom activities was provided by ACTT, using *Building ACTTive Futures: ACTT's Curriculum Guide for Young Children and Technology* (Hutinger, et al., 1990)[1]. Based on ideas and themes found in interactive computer software, curriculum experiences were designed to: (1) foster children's expectations of control over the environment and develop a sense of autonomy; (2) provide opportunities to participate in equalized play activities; (3) provide communication potential; (4) include most areas of the general curriculum; and (5) enhance problem solving and higher order thinking. The flexibility, structure, content, and usability of ACTT's curricular applications and procedures provided a good fit with Just Kids' existing curriculum and met requirements for children's IEPs.

The ACTT curriculum (1) assumes that child-directed activities produce positive results, an assumption that was supported in the ECCTS findings and (2) stresses the importance of

[1]This curriculum guide was revised in 1997 (Hutinger, Johanson, Robinson, & Schneider) and again in 1998 as *Building InterACTTive Futures*. It is available from the Center for Best Practices in Early Childhood Education.

integrating technology activities with ongoing classroom activities and children's educational experiences. Assistive computer activities were designed to encourage communication, cooperation and social interaction among children and adults in an inclusive environment and were integrated into the general curriculum content areas, including emergent literacy, art, social studies, and mathematics.

Since a developmentally appropriate curriculum was already in place at Just Kids, the ACTT curriculum model did not conflict with established procedures and was generally easy for the teachers to understand and use. Implementation was enhanced by the purchase of appropriate, up-to-date computers, software, and adaptive devices for each classroom involved in the study.

Technology assessment. Including the team-based TTAP (Team Technology Assessment Process) demonstration (Hutinger, 1993b) and outreach (Hutinger, 1998) models as part of ECCTS provided thorough technology assessments for children with moderate to severe disabilities. The TTAP assessments determined appropriate technology applications that could optimize children's development and allow access to activities in the general curriculum. Members of the Just Kids Tech Team who already served on a comprehensive assessment team received TTAP training from the Macomb Projects team on procedures to use before, during, and after the assessment. Encouraging family participation, gathering background information, selecting equipment and software for the assessment, conducting the assessment, writing recommendations for equipment and software that would be most beneficial to the child, and conducting follow up assessments were among the training topics. This component underwent the greatest modification in order to accommodate the assessment philosophy and requirements at Just Kids, the differing policies of receiving school districts, and state policies of New York.

Transition. The Bridging Early Services Transition (BEST) model (Rosenkoetter & Schotts, 1991, Rosenkoetter, Fowler, & Haines, 1994), designed to smooth the transition process for children and families, was proposed as the basis for ECCTS' transition activities. However, Just Kids was already using a transition model when the project began. To determine that model's effectiveness compared to the BEST model, three judges—two early childhood experts (one a past president of DEC), and an expert researcher—made independent observations and concluded that the transition process already in place at Just Kids followed the BEST model almost step for step. The transition philosophy stressed interagency collaboration and family involvement. Inclusion of children's assistive technology goals in IEPs and the communication between Just Kids and more than twenty receiving school districts regarding children's technology use were of primary interest to ECCTS.

Summary. The foundation of the 3-year research project was formed from proven model components combined into a rational, comprehensive technology system. A combination of tested, effective models was accompanied by ongoing staff development and a study of policies that help or hinder technology use. Over the research period, implementing the four components resulted in positive changes that encompassed personnel and their skills and perceptions about technology, classrooms, children's characteristics and needs, and children's use of computers and software.

Project Goal

The major goal of ECCTS was to advance the availability, quality, use and effectiveness of technology in addressing the practical problem of improving technology access in early childhood programs. We accomplished this goal by implementing and studying the effects of the ECCTS components to determine what was needed to fill the gap created by the lack of comprehensive technology systems in programs for children from 3 to 5 years of age with moderate to severe disabilities.

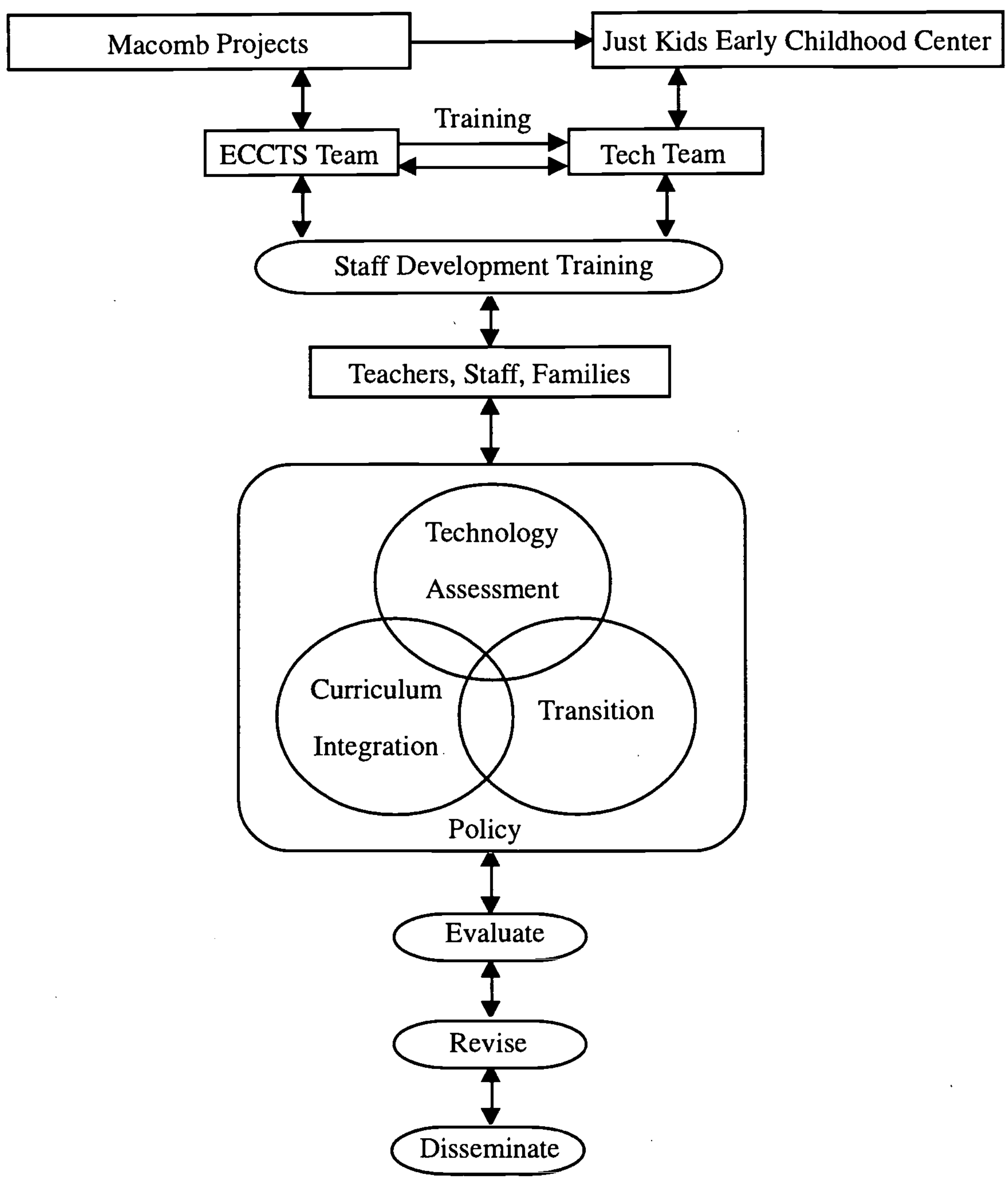
Context

ECCTS was implemented by two collaborating groups, Macomb Projects and the Just Kids Early Childhood Learning Center, and incorporated the participants and procedures detailed in Figure 2. At the onset of the project, Just Kids, a for-profit childhood center, had two sites and accepted approximately 900 children with and without disabilities from 71 Long Island school districts. The project began in the Middle Island site which housed 23 classrooms. The classes were half-day and inclusive, except for an all-day class for medically fragile children. Between 10 and 15 children were enrolled in each half-day class, depending upon the nature of children's disabilities.

Those classrooms had a Special Education teacher in addition to an Early Childhood teacher, program assistants, and/or children's personal aides. The school also provided speech/language and physical/occupational therapy services.

Figure 2. Early Childhood Comprehensive Technology System

Model Participants and Processes



The technology staff at Macomb Projects traveled to New York throughout the 3 years of the project to provide training and technical assistance to the staff at Just Kids. The Macomb staff trained a Technology Team at Just Kids to implement the components of the comprehensive technology system. At the same time, to expedite implementation of the system, the Macomb staff also trained the classroom teachers and assistants. Once trained, the Tech Team became the primary providers of training, technology support, and technical assistance.

How Goals Were Accomplished

Design. The study was based on a modified naturalistic paradigm using a mixed methods strategy as defined by Patton (1990) incorporating qualitative principles detailed by Filstead (1970), Lincoln and Guba (1985, 1989), Merriam, (1988), Tesch (1990), and Yin (1984). Units of measurement included (1) the integrated preschool classrooms, (2) children, (3) staff, (4) families, and (5) community schools and state agencies with interests in assistive technology experiences for young children. Data were collected to redundancy from the Macomb Projects' staff, the Just Kids' Tech Team, Just Kids teachers, Just Kids' administration and specialists (therapists), parents, children, and documents. Data included (1) qualitative data, (2) content or case analysis, and (3) selected quantitative data.

Rigorous documentation included observations of children and staff, interviews with staff and families, examination of records and materials, input from focus groups, and content analysis. During the 3-year period, project researchers made more than 900 hours of observations of 44 study children and 43 teachers. (Note: Children were not always placed with the same teachers in the same classrooms after their first year's participation in ECCTS.)

Figure 3 shows the evaluation measures used for children and staff and the schedule for data collection. Children in the study were observed during daily activities both in and outside their classrooms. Field notes and videotapes were analyzed. Field note content, videotapes, interviews, interesting incident reports, and other narrative data were coded, classified, and grouped according to a coding system which was derived from a logic tree developed from ECCTS research questions (e.g., Does the curriculum and its adaptations used in ECCTS effect positive changes in

Figure 3. Child and Teacher Data Collection Measures and Schedule

Measure	Child	Teacher	Schedule
• Observations	X	X	2 - 4 times per month per child
• Analysis of "Activity Result" Matrix	X		Annually
• Teacher Reports to Parents	X		Monthly
• Teacher Incident Reports	X		Weekly
• Teacher Phone Interviews	X	X	Annually
• Parent Phone Interviews	X		Annually
• SPED Teacher Evaluation Reports	X		Annually
• Brigance Diagnostic Inventory of Early Development	X		At beginning and end of school year
• Behavior Interaction Tool	X		At beginning and end of school year
• Macomb Projects' Staff Interviews	X	X	Annually
• Assistive Technology Child Progress Reports	X		Annually
• Just Kids' Administrators' Report	X		Annually
• Assessment of Teachers' Compliance with the ECCTS model	X	X	Annually
• Technology Self-Assessment		X	At beginning and end of school year
• Macomb Projects' Staff Assessment of Just Kids' Teachers' Technology Competencies		X	At beginning and end of school year
• Focus Groups		X	Once (during Year 2)
• Transactional Evaluation of Teacher Attitudes and Concerns		X	Beginning and end of Year 1, End of Year 3

communication? in listening and attending? in elements of emerging literacy? in social interaction?). Data were entered into the *Non-numerical Unstructured Data Indexing, Searching, and Theorizing* (*NUD.IST,* 1993) database. The coding system contained two classes of text, "activities" and "results." The program counted the number of times an activity category intersected with a result category and the number of times an "activity" category was followed by a "result" category. From this information, an Activity-Result Matrix was created.

Other child measures included: (1) the *Brigance Diagnostic Inventory of Early Development* (Brigance, 1978); (2) *Behavior Interaction Tool (BIT)*(Hutinger, Harshbarger, & Struck, 1996); (3) Teacher Incident Reports; and (4) interviews with teachers and families. The *BIT,* an observational measure, focuses on children's behaviors at the computer. Its 12 independent subtests are (a) Attending, (b) Resisting the Computer, (c) Cause and Effect, (d) Expression, (e) Follows Directions, (f) Independence, (g) Planning, (h) Calling Attention to Self in a Positive Way, (i) Calling Attention to Self in a Negative Way, (j) Peer interaction, (k), Cooperating with Peers, and (l) Competing with Peers. Teachers used "incident reports," collected weekly, to record interesting incidents occurring at the computer or children's behaviors of interest to ECCTS. Descriptive and comparative case studies of classrooms and children were developed, as was a policy summary. During the first year, case studies were developed for 15 children.

Teachers and staff measures, in addition to observations, are shown in Figure 3 and included (1) Technology Self-Assessment; (2) Transactional Evaluation of Teacher Attitudes and Concerns; (3) Focus Groups; and (4) interviews. The Transactional Evaluation instrument was made up of items contributed by the teachers. The purpose of Transactional Evaluation was to identify the problems teachers encounter in matching their personal needs and philosophies to institutional changes in expectations and demands (Rippey, 1998). The results can identify impediments to lasting change. In addition, Tech Team members responded to *A Technology Self-Assessment for Special Education Professors* (Blackhurst, Lahm, Shuping, & Bell, 1997) near the end of Year 2. Over the 3-year period, all 43 study teachers were interviewed personally and by phone, for a total of 172 interviews.

Twenty-eight parents agreed to be interviewed during the first 2 years. In Year 3, 12 parents (70%) of children who transitioned from Just Kids participated in follow-up interviews. All receiving schools were visited and school administrators were interviewed, either personally or by phone.

Multiple data sources contributed to reported child outcomes and staff outcomes. Reported findings underwent triangulation so that results derived from one source of data were supported by at least two other data sources among different times and classrooms, children, staff, family members, or other factors of interest to ECCTS. Findings were compared to the results of four sister collaborative research projects, funded by the USDE and conducted across the same period of time as ECCTS, demonstrating some similar results across other age groups and purposes[2]. Data analyses, summaries, and case studies were member checked and audited according to the stringent procedures required for qualitative research.

Subjects. The project studied 44 3-, 4-, and 5-year-olds with moderate to severe disabilities in depth. Fifteen of these children participated in the project for 2 years, while one child participated for 3 years. Children were spread across six classrooms in Year 1, seven classrooms in Year 2 (one continuing classroom and six new classrooms), and nine classrooms in Year 3. The number of study classrooms and numbers of children by year are shown in Table 1.

As demonstrated in Table 2, each year brought changes in the distribution of disabilities for study children. Specific diagnosis of some study children changed between Years 2 and 3, resulting in disabilities appearing in the Year 3 column that did not appear in the Year 2 column, even though 15 of the 32 Year 2 children remained in the study during Year 3. A total of 654 children other than those studied in depth participated in technology activities. Of these, 317 were diagnosed with disabilities.

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[2] The document, *Promising Practices in Technology: Supporting Access to and Progress in the General Curriculum*, is now in press and will soon be available on the OSEP "TechIDEAs that Work" web page <http://www.air.org/TECHIDEAS/reports.html>.

Table 1. Number of ECCTS Study Classrooms Each Project Year and Children With and Without Disabilities who Participated in Those Classrooms

	Number of Study Classrooms	Children with Disabilities	Children Studied in Depth	Children without Disabilities	Total Children in Study Classrooms
Year 1	6	56	16	45	101
Year 2	7	67	32*	40	107
Year 3	9	80	15**	29	109

* Four of the 32 Year 2 study children were involved in the project during Year 1.
** Fifteen of the Year 3 study children were involved in the project during Year 2.
One child participated all 3 years.

Selection criteria for inclusion in the study. The following criteria were used to determine which children were involved in the study.

1. **Team referral.** A Special Education teacher, an Early Childhood teacher, a school psychologist, and other support persons (i.e., Physical or Occupational Therapist, Speech/Language Therapist—depending on the child's disability) were members of the referral team which met to consider children for referral for the study. Two basic factors were considered: (1) the child's disability and (2) the potential of technology for benefiting the child.

Table 2. Distribution of Children's Disabilities Over the 3-Year Period

Disability	Year 1	Year 2	Year 3
Multiple Systems Disorder (MSD)	4	15	5
Cerebral Palsy	2	2	0
Behavior Disorder	3	0	0
Down syndrome	2	1	0
Attention Deficit Hyperactivity Disorder	2	0	0
Low Functioning	2	0	0
Elective Mutism	1	0	0
Pervasive Developmental Disorder	0	0	3
Learning Disabled	0	2	2
Speech Impaired	0	8	3
Visually Impaired	0	2	1
Mental Handicap	0	0	1
Multiple Handicap	0	1	0
Medically Fragile and Orthopedic Impairment	0	1	0

2. **Teacher agreement to participate in the study.** Once referrals were received, the children's classroom teachers were contacted. Project ECCTS was explained; then they were given the opportunity to become involved. Some requested to be a part of the study. Some were sought out based on the number of children referred from their classroom. The goal was to select the least number of classrooms with the most number of children for participation in ECCTS.

3. **Parental agreement for the child to participate in the study.** Children's involvement depended on this factor. If parents did not agree to their child's participation, the child was no longer considered for the study.

Procedures. An overview of the procedures used is shown in Figure 2 on page 7. Starting with a small group of teachers and classrooms, the project expanded as success grew. Ongoing training and support at two levels (Macomb Projects and the Tech Team), focused on teachers and professional staff, thereby increasing and maintaining individual staff knowledge, skills, and satisfaction related to current hardware, software, adaptations and market offerings.

Training. Macomb Projects furnished the experienced staff of technology trainers who trained Just Kids' teaching staff as well as the on-site three-person Tech Team. Eleven 2- and 3-day training events were held—four in the first year, five in the second year, and two in the third year. Training was sometimes conducted in large groups which included both teachers and Tech Team members. At other times, the group was divided so the Tech Team could receive more extensive training than the teachers. One-on-one sessions for both training and technical assistance in response to specific requests were held for individual teachers and Tech Team members. All training participants learned to set up appropriate computer learning environments, operate the computers, use adult productivity software (i.e., data bases, spread sheets, word processing, desk top publishing), evaluate and select appropriate interactive software, connect and use adaptive peripherals, and customize materials for individual children.

The ECCTS system depended on the effectiveness of the Tech Team, so developing an independent, knowledgeable Tech Team was Macomb Projects' first priority. The Macomb Projects' trainers focused Tech Team training around principles of adult learning, tested successful technology training strategies, troubleshooting, technical problem solving, software evaluation and selection, adaptive devices, and curriculum integration. Macomb Projects' trainers trained the Tech Team so they could effectively teach skills and provide technical support to teachers on an ongoing basis. By the third year, the Tech Team provided the majority of the technology training and support to Just Kids' teachers, therapists, and families.

The Tech Team traveled to Macomb three times for training, technical assistance, and to member check evaluation reports. The ECCTS evaluator traveled to Just Kids 11 times to establish data collection procedures, to collect data, and to report findings to site personnel. At least three times a week, communication via phone, email, or fax occurred between Just Kids' Tech Team and one or more of Macomb Projects' ECCTS staff members.

The training approach led to an increasingly skilled Tech Team, as well as teachers' increased use of effective hardware and software applications and adaptations in early childhood classrooms. Increases were seen in teachers' use of adult productivity software and in early childhood curricular areas. In turn, children showed progress across developmental areas. The functional, well-trained, on-site Tech Team established at Just Kids provided the necessary leadership and support that made the system cohesive, contributed to effective technology use, and led to maintenance of the system when external funding ended.

Materials and products. A wide range of materials, including curricula and modular learning materials, were developed by Macomb Projects prior to the beginning of the study. These were used to train Just Kids staff on technology use, assessment, and curricular integration. The Tech Team incorporated the Macomb Projects' materials and added to them to develop their own training manual, *Assistive Technology Handbook.* A close-captioned videotape, "Supporting A Comprehensive Technology System: Roles of An On-site Support Team," describing the responsibilities and benefits of the on-site Tech Team, was produced at Western Illinois University. Macomb Projects' staff designed a project web page. Linked to the Macomb Projects' web site, the ECCTS page <http://www.wiu.edu/users/mimacp/wiu/eccts/ECCTSHP.html> contains contact information, general information about the project, and links to articles that were written about ECCTS, its procedures, and its findings during the 3-year project period.

Modifications

An innovative model's flexibility, as well as the latitude it provides for modifications, contributes to successful adoption of that model. Flexibility allows a school to make the model its own and incorporate it into the existing culture. Only one element of ECCTS, the TTAP assessment model, underwent changes at Just Kids. Although TTAP served as an assessment guideline, adaptations were made by the Just Kids' Tech Team to accommodate site practices and local and state policies.

Since extensive information was available in children's school files, modifications to TTAP included simplified intake procedures, a modification that was not likely to have an effect on the outcomes. Just Kids' Tech Team indicated that TTAP provided a structure to the school's existing assessment procedures and that more assessment team members were included as a result of TTAP training. The Tech Team found TTAP assessment forms useful not only when they were conducting the assessment but also when they were writing the assessment reports. The longer assessment reports were summarized on one page and shared with teachers, while full reports were always available to teachers who needed more information about a child. Just Kids' Tech Team found a need to remind teachers about children's technology assessment results, so they developed a *Technology Evaluation Summary*, a shortened form of the assessment report that was distributed a few months after the initial summary.

Follow-up assessments emphasized in the model were seldom scheduled because the Tech Team member who headed the evaluation team had contact with all the study children on at least a weekly basis. Follow-up was based on her observations of the children's technology use and on-going conversations with teachers, aides, and parents rather than on a formal assessment[3].

Adjustments to the model were made because the degree of direct family involvement recommended in TTAP[4] was not always possible for every technology assessment completed at Just Kids for various reasons (time, distance from school, work schedule). Nevertheless, some families did participate directly in their children's assessment[5]. Other families were unable to participate in the assessment itself; however, these families were involved in planning the assessment, were interviewed by phone prior to the assessment, and were contacted by phone after

[3] If initial recommendations are not working, a formal team-based follow-up assessment is useful because parents and individuals with varying backgrounds bring different perspectives and views of children.

[4] Macomb Projects believes that family participation in technology assessments is more likely to lead to families having the skills and knowledge necessary to serve as advocates for their children and to contribute to the children's progress.

[5] Of 27 TTAP assessments given in the 3 years, 16 families (60%) participated.

the assessment. A copy of the assessment report was sent to families. The mother of a child with severe physical disabilities reported,

> The assessment itself was very thorough. I was very involved. Just being the parent of a child with a disability. . . .is important to be as involved as you can because you have to be an advocate for your child. Afterwards they went over the assessment with me to see what my feelings were and how I thought the assessment went. This was very good because I was able to give input and to explain how I see Melissa[6], like her eye contact and her physical movements. I explained how she communicates with me.

Problems and How They were Solved

Some of the problems encountered by ECCTS (e.g., those relating to technology recommendations and transition) were policy related. Their solutions were not within the power or scope of this project. Others were similar to those that might occur in any school, such as high staff turnover from year to year, a shortage of substitute teachers, and less than optimum family involvement.

Technology recommendations. The main purpose of a TTAP assessment is to find and recommend appropriate software applications and technology adaptations for the child being assessed. At the time ECCTS was implemented at Just Kids, the county's rules did not allow specific recommendations to be made in evaluation reports of children with disabilities. To comply with this ruling, the TTAP section recommending software, adaptive peripherals, and other equipment based on the results of the technology assessment was eliminated from the reports sent forward as children moved into new placements.

Transition. Just Kids' children may be placed in one of more than 70 Long Island school districts. To prepare children and families for transition, Just Kids' transition activities included parent conferences, information about support systems, referral to legal advisors, and classroom activities related to preparing children for kindergarten. The addition of the assistive technology

[6] Names of children referred to in this report have been changed.

component to the transition process was one that was welcomed by Just Kids' Director of Education, who commented:

> ...we have been working to transition children in general, but we have been working with this project in transitioning their assistive technology needs to the districts so they can see the equipment, the technology, how to position the child, how the child best benefits from the use of technology. That is something we are all excited about.

Unfortunately, Just Kids' expectations of incorporating assistive technology into the transition process had to be modified because the receiving schools' responses to transition procedures differed. Sometimes technology information from Just Kids was welcomed; other times it was ignored. Therefore, as far as ECCTS children's technology requirements were concerned, transition into public schools met with varying degrees of success and failure, depending on the receiving schools' policies, communication with Just Kids, and attitudes toward accepting recommendations and working with Just Kids and the families.

Receiving schools' computer availability and technology policies differed. The majority of the kindergarten classrooms had older computers, such as Apple IIe and Apple IIGS models. At Just Kids, children had been using new Power Macs, so their expectations about software interactivity were often not met due to the lesser capabilities of the older computers' software. Administrators of 30 elementary school districts that received children who attended Just Kids were interviewed by phone. Only three indicated that their schools have a written transition policy and only three responded that their teachers "always" receive in-service training about children's transition to kindergarten. Districts' assistive technology policies seldom went below third grade. Equipment did not follow children, a factor that hinders technology use for children and families (Hutinger, Johanson, & Stoneburner, 1996). In addition, it was not until the end of the 3-year project that approved state technology policies were in place. This factor influenced districts' technology policies and practices and determined how district personnel responded to the technology information they received from Just Kids.

Just Kids collaborated effectively with many of the receiving schools and had appropriate transition policies in place. When the Tech Team and representatives from the receiving school worked together to decide how technology could be implemented to best benefit the child, the transitions were successful. Some schools were pleased to receive and incorporate the technology-related information and made sure that children continued to use the assistive devices they had been using at Just Kids. For example, one school district representative contacted a member of the Tech Team and asked her to submit a "wish list" of technology equipment and software appropriate for Nathan, who would be transitioning to that district. Not only did the district purchase the items on the list, but it also requested that the Just Kids' Tech Team member provide inservice training to help the child's new teacher learn to use the equipment. Timika's receiving school principle also visited Just Kids for guidance in preparing the school for the her needs. The receiving school followed all of the Just Kids' suggestions, and the parent interview shows great satisfaction with the transition.

Unfortunately, these examples were exceptions. Often, the receiving schools were not concerned about the technology and demonstrated a decided lack of interest in recommendations about the children's technology needs. For example, a child involved in the ECCTS study was diagnosed as having autistic tendencies. He also had a severe hearing disability. Once speakers were installed by the computer in his Just Kids' classroom and he could control the volume, he became an active user of the computer and was generally well-behaved in the classroom. When it came time for him to transition, one of the Tech Team members spent considerable time with personnel from his receiving school explaining his problems and needs and describing the success he had using the technology at Just Kids. Her advice went unheeded. When school began, Jared's classroom had no computer, nor was the necessary auditory assistance available. After the first week, Jared's teacher, who had received no information from the personnel who spoke with the Tech Team member, concluded that he was a behavior problem and referred him for disciplinary action. He was placed in a room for children with behavioral problems where the situation worsened until continued pressure from his parents and the arrival of a hearing aid and auditory trainer resulted in his placement in a more appropriate classroom.

Sadly, ECCTS was not able to solve the problems involved with the transition process. Initially, state and county policies forbade Just Kids from sending specific assistive technology recommendations to other agencies.[7] IEPs were generated by each school district's Committee on Special Education. As a result of policy, Just Kids was unable to send specific recommendations to the committees until the third year of the project. Thus, no formal assistive technology recommendations were made for graduating children's IEPs during Years 1 and 2. In Year 3, the Committee included assistive technology recommendations in IEPs for only 3 of 15 children, and recommendations were *fully implemented* for only one of those three children. For the most part, throughout the project's 3 years, Just Kids' Tech Team could do little more than ensure that the receiving districts' teachers knew the child's technology information was available to them if they wanted it. However, since any informal recommendations from Just Kids were not in the children's IEPs, the receiving schools could, and usually did, ignore them.

Parents of children who transitioned to kindergarten completed a questionnaire relating to their child's transition experiences. Twelve (70%) of the parents returned questionnaires. Answers indicated that the children were doing well in their new schools but there was little or no technology use. Receiving schools had conducted technology evaluation for only 2 of the 12 children whose parents responded to the questionnaire. Nine of the 12 responses indicated that there had been no follow up on the children's technology recommendations. Some children's parents purchased home computers when it became clear that the schools were not going to provide computers for their children. Other children, whose families could not afford to purchase technology for home use, were forced to do without. These were children like John, who at Just Kids wrote a series of storybooks at the computer, and Ronny, who learned to use the computer at Just Kids with his Braille keyboard.

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[7] This restriction was eased in 1998-1999.

ILA. ECCTS staff used the *Informal Literacy Assessment (ILA),* a 12 question checklist developed for Macomb Projects' technology and literacy research study, to help determine the effects computer use had on children's emerging literacy skills. *ILA* results from *The Early Childhood Emergent Literacy Technology Research Study* were effective in documenting children's emergent literacy progress (Hutinger, et al., 1998), and ECCTS was interested to discover if using the computer and story-based software would produce similar results for children involved in this study. The ILA was administered during each of the 3 years, but protocols for administering the ILA underwent changes each year as Just Kids' Tech Team tried to find a way to make the instrument "work" for them. Therefore, comparing results from year to year was not feasible. Problems also arose because (1) one entire set of observations on the ILA is based on the child's interactions as he/she is being read to, and reading to individual children was not part of the classroom environment at Just Kids; and (2) the nature of some children's disabilities (e.g., inability to use their fingers to point to words or pictures) meant that not all children could be assessed with the ILA. These conditions resulted in the decision to eliminate the ILA from analysis. However, children's emergent literacy skills *did* improve, and this improvement was documented in observational data, as explained in the **Child Outcomes** section.

Staff turnover. Each year teacher turnover at Just Kids was greater than anticipated, which meant that basic technology training had to be repeated for new teachers. This training took extra time and created more responsibilities for the Tech Team. However, by the second half of Year 2, the Tech Team members were proficient and capable of conducting the extra training sessions themselves with less reliance on the Macomb staff.

Substitute teachers. As implementation progressed, teachers throughout the building learned about the positive effects the technology was having in the ECCTS classrooms. As a result, more teachers requested to participate in the technology training. Finding substitute teachers became a major obstacle. The project budget allowed sufficient funds to pay for substitutes, and the Just Kids administrators were agreeable to hiring substitutes while teachers were involved in the technology training. However, few substitutes were available in the area, and those that were available were in high demand. So the Just Kids Tech Team did some creative problem solving to find times when teachers could attend trainings. Monthly "Curriculum Breakfasts," held in the morning before school started, became one of their most effective solutions. At least a week before the meeting, teachers were given a software program to review, along with a curriculum integration activity form. At the breakfast, over coffee, juice, and donuts provided by the Tech Team, teachers, aides, and Tech Team members gathered to discuss the software and brainstorm ways its content could be integrated into classroom curricular activities. Other training activities took place after school or one-on-one with teachers in the classrooms. When substitutes were available, group training sessions were scheduled for the teachers and aides who could attend.

Family involvement. Part of the Tech Team's responsibilities was to involve families in the technology activities. This involvement took many forms, depending on family circumstances and interests. Families were kept well informed of technology happenings in the classroom through newsletters and other school-to-home communications.

The Team informed families about the materials available for inspection and loan in the Just Kids' technology resource library. Families were also notified that the Team was available for answering questions or providing technical assistance to families who were interested in technology-related information. The Tech Team also provided training opportunities to help families understand and use technology so they could provide their children with computer experiences at home or at the local public library. Training included workshops and one-on-one consultation.

Formal family involvement activities aimed at technology planning and participation in intervention were offered but were not well attended[8]. Many parents had long distances to travel to the school. Some lived as many as 60 miles away, and transportation was not always available. Both parents in many families were employed and were unable to attend activities scheduled during the school day. Time after work was precious, so evening activities did not appeal to them either. Even

[8] During Year 1, 4 (25%) of the parents attended school-sponsored technology activities. In Year 2, 6 (18.8%) attended technology activities. None attended in Year 3.

workshops held on weekends resulted in low attendance. However, the Just Kids' Tech Team offered technology workshops that families could take advantage of when their schedules allowed. Child care was always provided. Those families who were able to attend the workshops reported enjoying the experience and said they left with more knowledge about technology use in the classroom, familiarity with some of the software their children were using, and information about technology's benefits for their children.

Resource materials available to families included a library of materials, such as software and switches, to check out, as well as regularly-distributed technology newsletters from the Tech Team containing news about ECTTS activities. A few families sought advice from the Tech Team regarding the purchase of computers and software for the home and about their children's transition and technology access. Some families—five in Year 1, seven in Year 2, and four in Year 3—had computers at home.

Lydia Okrant, Coordinator of the Just Kids' Tech Team, commented on the projects' focus on families:

> Initially we were hoping that parents would become involved in the technology ... The project itself looked at parents' involvement at three different levels, from awareness to actually getting involved in the technology with their children. The parents are all involved in that they are all aware of what's going on. Some parents are now at the comfort level where they do come in and borrow our software. Anyone can take it home, use it with their children [and] with their families and see whether it fits their needs and if they want to buy it or not. We have had some parents who are purchasing computers and peripherals and have asked for advice on what types of computers and peripherals to buy for their children.
>
> One way that we found to reach all of the parents was a parent newsletter that we send home in the backpack. We gave them different tips [about] software. We also gave them e-mail or www addresses...that might be of interest especially if they have particular disabilities. We try to give them good information on a variety of subjects...

The first workshop that we had for the parents, we had software available, different software that we used with the children. We also made some fun activities by learning to use *PrintShop* and how to do invitations. We used the digital camera, took some pictures of the children that were up in baby-sitting, made transfers out of them and a couple [of parents] walked out with T-shirts with their children's pictures on them. So we try to make it interesting, something that the parents would want to do.

Summary of Results of the Research

The study's major findings point to teachers' increased technology skills, to benefits for children, and to conditions that promoted maintenance of the system after the funding cycle was completed. A summary of findings is presented here. ECCTS' principles (see Appendix A) and findings were incorporated into a collaborative document (see Footnote #2) produced by the five180U projects that received funding in 1995[9].

Teacher Outcomes

If technology integration is to succeed, teaching staff must be involved in planned, on-going, hands-on training by expert trainers who understand the potential of technology, the needs of children, and the positive elements of adult learning. As a result of ECCTS training, the multiple data sources shown in Figure 4 revealed that teachers acquired knowledge, skill, and a positive comfort level related to using computers, software, and adaptive devices and integrating software into the curriculum. These data sources also indicated that teachers, parents, and administrators were more likely to use computers when they were taught to use adult productivity software such as word processing, data bases, and spreadsheets, in addition to software applications for children. From the resource library maintained by the Tech Team, teachers could check out software, adaptive

[9] These five projects were Beyond Assistive Technology: Policy, Curriculum, and Technology for Inclusion (CAST, Inc.), PR #H180U50035; Examination of the Effectiveness of a Functional Approach to the Delivery of Assistive Technology Services in Schools (University of Kentucky), PR #H180U50025; Formulate and Conduct Research Around Improving Education and Technology Related Services at the Local Level (Children's Hospital, Boston), PR #H180U50026; Implementing Technology Related Policy in the Schools: Fostering Ownership and Change at the Local Level through Participatory Action Research (National Center for Disabilities Research), PR #H180U50022; and The Early Childhood Comprehensive Technology System (Western Illinois University), PR #H180U50039.

devices, and print materials, preview them, and learn how to set them up and make them work before they used them in the classroom.

Figure 4. Data Sources Indicating Teacher Outcomes

Measures / Teacher Behavior	Observations, Videotapes, Transcriptions, Coded Field Notes	Teacher Phone Interviews	Macomb Projects' Staff Interviews	Technology Self Assessment	Macomb Projects' Staff Assessment of Just Kids' Teachers' Competencies	Transactional Evaluation of Teacher Attitudes and Concerns	Focus Group Reports	Assessment of Teachers' Compliance with the ECCTS Model
Teachers learned technology skills that helped them with routine tasks (e.g., word processing, data base, spreadsheets).	●	●	●	●				●
Teachers learned strategies for including children with disabilities in classroom activities.		●	●	●		●	●	●
Teachers learned to evaluate and select software to enhance curricular goals.		●	●	●				●
Teachers became comfortable with integrating software and activities related to software into the curriculum.	●	●			●			●
Teachers learned to use *HyperStudio* to develop software that was meaningful to the children in their classrooms.	●		●		●			
Teachers learned strategies for effectively managing the computer center (e.g., using *KidDesk*, using sign up sheets, allowing pairs and groups of children at the computer, discontinuing use of the computer as a reward).	●	●	●		●			●
Teachers learned simple troubleshooting techniques.	●	●		●	●			●

As a result of teacher participation in training provided by the Macomb staff and Just Kids' Tech Team, regular classroom observations showed teachers increased classroom computer use as well as software integration throughout the curriculum. They learned appropriate ways to arrange the computer center to make it more conducive for children's use (e.g., putting the monitor at the children's eye level). Their technology skills progressed as they continued to participate in the training and to put into practice what they learned. Preparing books of children's art and/or writings; creating *HyperStudio* stacks to meet individual children's or classroom needs; and reproducing children's artwork were among the ways teachers used technology. They also used technology applications to quickly produce letters, cards, newsletters, invitations, announcements, certificates, posters, and banners for classroom or personal use.

Teachers used the computer in a number ways that promoted children's learning or helped children access the general curriculum. They began using larger fonts for children with visual disabilities; Braille keycaps for children who were blind; and talking literacy-based software that read stories to children with visual impairments.

Teachers learned to use *HyperStudio*, an authoring program to create software that met individual needs or that was unique to classroom experiences. With adult help, children contributed to situation-specific software using their own drawings, photographs, videotape, sound, animation, and text. Teachers planned and prepared *HyperStudio* stacks for individual children or for classroom activities, often using the software to simulate visits to the airport, firehouse, or other community locations.

Teachers also used software and hardware to prepare books of children's writings or to introduce basic science and math concepts. Children's artwork was reproduced for inclusion in classroom books of *HyperStudio* stacks. Children's photos were printed on labels that were used to identify children's lockers, lunch boxes, and other property.

Successful technology integration into the curriculum was improved as teachers became more comfortable using the technology and gained competency in basic skills such as (1) the ability to keep the computer going in the face of small mishaps; (2) the ability to help children with software when they got 'stuck'; (3) knowledge and ability to use utility programs such as *KidDesk* and *HyperStudio*; and (4) knowledge of and ability to use interactive instructional programs such as the Living Books series and *Kid's World.* Teachers' reports on the Technology Self-Assessment (of computer competency) dramatically demonstrate gains in their understanding and use of technology and its integration into the curriculum. On the 68-item instrument, three-fold or better gains were registered on 37 of the topics while no areas showed a decrease. Scores of all teachers on the computer competencies instrument increased substantially from acquisition of 17% to 79% of the competencies between the beginning of Year 2 and the midway point in Year 3. These results include five teachers who participated for only half a year.

As the teachers involved in the ECCTS study observed the benefits of technology for themselves and for the children in their classrooms, they spread the news to their colleagues, and expansion into other classrooms occurred. Sometimes teachers who initially resisted technology later became advocates as they saw the advantages technology offered the children. For example, a Special Education teacher was overwhelmed by the computer in Year 1. However, she had a daughter with a disability who was in one of the ECCTS classrooms and who liked the computer. After witnessing her daughter's success with the computer, this teacher obtained a computer for her child from the Starlight Foundation and learned more about computers from the Tech Team and her daughter. In Year 2, even though she had been transferred to a class of very young children who were not part of the ECCTS study, the teacher became an active computer user with her class and frequently brought one of the remaining hallway computers into her classroom. She continued to use the technology in Year 3 with her class of 3 year olds.

Child Outcomes

The computer applications and adaptations incorporated in ECCTS offered a wide range of documented benefits to young children with disabilities, including access to the general curriculum. Numerous data sources, as shown in Figure 5, indicate children's successful achievement (i.e., they were able to *do* something, to accomplish an activity) when technology was used to support learning. Observational data, "Teacher Incident Reports," parent interviews, and reports from Just Kids' administrators and Macomb Projects' staff support that finding.

Figure 5. Data Sources Indicating Child Outcomes

As a result of using the computer in accordance with the ECCTS model, children:	Observations, Videotapes, Transcriptions, Coded Field Notes	Teacher Reports to Parents	Teacher Incident Reports	Teacher Phone Interviews	Parent Phone Interviews	Member Checking	SPED Teacher Evaluation Reports	Brigance Scores	Behavior Interaction Tool (BIT)	Just Kids' Administrators' Reports	Macomb Projects' Staff Interviews	AT Child Progress Reports	Analysis of "Activity Result" Matrix	Assessment of Teachers' Compliance with the ECCTS Model
1) achieved success in carrying out computer-related activities	●	●	●		●	●				●	●			
2) participated in activities in which they might not previously have been able to participate	●	●	●		●	●	●			●	●	●		
3) increased self-esteem and self-confidence	●	●		●		●					●	●	●	
4) increased fine motor skills and visual motor skills (tracking)	●			●		●								
5) decreased aggression	●			●	●								●	
6) increased engagement and attending behaviors	●			●	●			●	●		●	●	●	●
7) increased social skills, such as sharing and turn taking	●	●			●	●	●	●	●			●		●
8) increased language use and communication	●		●		●	●	●	●	●					
9) used and improved cause and effect reasoning	●			●	●			●	●		●		●	●
10) increased emergent literacy behaviors and developed new literacy skills	●			●	●			●	●		●		●	●

Sequential observations, videotapes, and field notes revealed six stages of computer use through which children progressed, with some variation, when computers and related adaptations and software were treated as another learning center in an early childhood classroom and when children have free access to the center and freedom to choose software. The stages were (1) watching from a distance as others use the computer, (2) moving in close and occasionally commenting, (3) working at the computer with a teacher, (4) working passively at the computer with another child, (5) cooperating with another child at the computer, (6) helping another child at the computer or explaining a discovery or sharing knowledge about the computer with other children and teachers.

Classroom computer experts. Competence related to successful computer use, in turn, increased children's self esteem, as indicated by teachers in their reports to parents, in interviews with teachers and with Macomb staff, in Assistive Technology progress reports, and in results from the Activity-Result Matrix. Some children took on the role of classroom 'computer experts,' children whom their peers recognized as people who could help them navigate through software and whom they turned to if they needed help. In one of the rooms, Shaniece was the computer expert. Her teacher had this to say:

> Ah, Shaniece, our computer ace. She has used every program. She likes the higher function programs like *Millie's Math House* and *Bailey's Book Hous*e...She has learned a lot from it and is very swift with the mouse. She also teachers the others kids very well ... The kids give her a lot of respect.

The Coordinator of the Tech Team described a child with visual impairments who was one of the youngest children in the class during his first year in the study. He was very shy and tended to stand back and watch the other children. She said:

> He didn't really have any friends and was kind of a looker plus visually impaired. When he got on the computer, all of a sudden he was socializing with other children; he was having friends. He learned how to control the mouse and how to play the games and worked on his self confidence. He happened to be the only child that remained [for a second year] in that room. All these new guys came in and now he is the big guy. He is the oldest one and he really knows the computer and is able to become the teacher and trainer for the other

children. It is wonderful to be able to observe and watch him feel so comfortable and so proud of his abilities. The other children come to him for help.

Social-emotional growth. Children progressed in all developmental areas, including social-emotional, fine motor, communication, cognition, gross motor, and self help (see Figure 5). Brigance scores were analyzed for a subset of 15 children who participated in the study for 2 years. Their progress from the beginning of Year 2 and to the beginning of Year 3 is shown in Table 3. The average rate of progress from birth to the beginning of Year 2 was .52 months per month, a level of development consistent across six sub-scales relevant to ECCTS: communication (.44 months), cognitive (.46 months), social-emotional (.49 months), fine motor (.52 months), self-help (.53 months), and gross motor (.68 months). This group progressed at half the rate of the children who were used to standardize the Brigance. In contrast to the Year 2 results, these children's Year 3 Brigance scores demonstrated a mean rate of progress of 1.81 months per month, a level of development consistent across communication (2.05 months), cognitive (2.27 months), social-emotional (1.93 months), fine motor (1.72 months), self help (1.58 months), and gross motor (1.22 months) sub-scales. Moreover, after participation in ECCTS, 14 of the 15 children doubled their per month gain. Six of the children's Brigance scores exceeded their chronological age for the first time in their lives.

Those who fear that computer use automatically leads to isolated, solitary behavior can put their fears to rest. Social skill growth in all 44 of the study children was associated with computer use, according to teacher and parent interviews, observational data, and BIT scores. During a focus group session, one teacher commented, "It [the computer] bridges the children. There are some things that I could never teach them that they are getting on the computer. The children also form a kind of bond when they work together on the computer."

Some children diagnosed as Multiple Systems Disorder (MSD) or Pervasive Developmental Delays (PDD) began to socialize and talk in the computer environment. The Tech Team leader reported,

Table 3. Comparison of 15 Children's Year 2 and Year 3 Scores on Selected Sub-scales[a] of the *Diagnostic Inventory of Early Development*

Child	Chronological Age at Year 2 Testing	Developmental Age	Gain Per Month Since Birth	Chronological Age at Year 3 Testing	Developmental Age	Gain Per Month Since Birth	One Year Gain Per Month
1	3.92	3.00	0.77	4.92	5.5	1.31	2.50
2	3.75	0.75	0.20	4.75	1.17	0.25	0.42
3	3.92	3.25	0.83	4.92	5.25	1.07	2.00
4	3.50	3.00	0.86	4.50	4.67	1.04	1.67
5	4.08	2.58	0.63	5.08	4.75	0.94	2.17
6	4.00	1.17	0.29	5.00	1.58	0.32	0.42
7	3.67	1.50	0.41	4.67	4.08	0.87	2.58
8	3.67	2.08	0.57	4.67	4.83	1.03	2.75
9	3.83	2.50	0.65	4.83	4.58	0.95	2.08
10	3.75	1.58	0.42	4.75	3.58	0.75	2.00
11	3.92	1.25	0.32	4.92	2.83	0.58	1.58
12	3.42	1.17	0.34	4.42	2.50	0.57	1.33
13	3.00	1.16	0.56	4.00	4.33	1.08	2.67
14	3.33	0.83	0.32	4.33	1.58	0.36	0.75
15	3.42	2.33	0.68	4.42	4.58	1.04	2.25
Mean	3.66	1.88	0.52	4.66	3.72	0.95	1.81

[a] Communication, Cognitive, Social-emotional,Fine motor, Self-help, Gross motor

Some of the children are labeled MSD (Multiple Systems Disorder) and are non-verbal. Many of these children are loners, they're isolated, they don't want anyone else around them, they need their own space. These children, of course, first were 'lookers' before they were 'doers,' and they had to watch to see what others were doing. Slowly they would go over to the computers but still they needed their own space. They weren't ready to be with other children. Maybe they didn't verbalize, they didn't communicate, but slowly through the use of Living Books, especially where it is a story and the words are spoken, these children started to communicate.

ECCTS data support findings from Macomb Projects' previous work (Hutinger & Clark, 2000; Hutinger, et al., 1998; Hutinger, Johanson, Stoneburner, 1996) that demonstrate the positive impact of computer use as a tool for learning to share. Deon, for instance, demonstrated severe behavior problems and was eventually moved into an ECCTS' classroom where the teacher integrated the computer into the curriculum. The field notes taken during observations of Deon document not only how he interacted with his classmates at the computer but also how Deon and his classmates demonstrated their technical expertise.

Deon and Andrew are using *Three Bears in the Dark.* A third child, Mark, joins them. One of the boys demonstrates some of the dancing in the program. Mark now gets his turn and he predicts the appearance of a dolphin in the bathtub. The boys imitate the scrubbing motions of the dolphin. They know the story by heart, and Deon recites it along with the program. Mark and Deon start the program again and dance with the circle time character. Then they sing the "Morning Song." They are having fun using the mouse and adjusting the volume. When the sound stops, they decide to go ahead without sound. . . then Deon fixes the volume. [To adjust the volume, Deon had to enter the system's folder.]

Mark and Deon discuss where to go in the program and decide to go back to the bathroom scene. They brush teeth, go to the hotspots, and mimic the actions of the characters. When the tub sings and dances, Deon says, "Look at that!" They scrub some more. [The boys have learned the structure of a rather complicated network of events and know how to move from one event to another.]

Behavior. Play, books, computer, art, and snack time, were among the 11 common classroom activities observed, coded, then entered into *NUD.IST* (1993). Results, compiled in an Activity-Result Matrix, showed that of the 11 activities, computer use was most often followed by desirable behaviors (e.g., sharing, communicating, turn taking) and least likely to be followed by aggression. The *NUD.IST* (1993) qualitative analysis software was used to count the number of times aggression took place across all classroom activities. According to analysis of classroom observations across all 3 years and 44 children, 93% of children's aggression occurred at activities *away* from the computer. The analysis further revealed that positive behaviors were associated with computer use. Communication and turn taking, for example, accounted for 63% of the text units associated with computer time (i.e., 35% communication, 28% turn taking). These results are comparable with the level of communication occurring during undifferentiated play (35% at computer, 43% undifferentiated play) and superior to the level of turn taking occurring during undifferentiated play (28% computer, 4% undifferentiated play). Children with behavior problems, those diagnosed as having autistic-like tendencies, and those who did not talk to adults exhibited fewer negative behaviors during computer use, interacted socially more often, and were more communicative (Hutinger, Johanson, & Clark, 1999; "Supporting A Comprehensive Technology System," 1998).

Attending. Teachers reported that children using the computer focused attention on the experience for longer periods (as compared to other activities), that the computer held children's interest, and that children tended to repeat an activity for relatively long periods of time. Observations made when children were using interactive software demonstrate an increase in their attention spans from less than 3 minutes to more than 15 minutes. One Occupational Therapist remarked, "The kids are immediately attached to it [the computer] and their attention span is greater for the computer. I've had children who were not able to sit or attend to anything for very long, but they were grasped by the graphics of the computer, the screen, and the sound effects."

Emergent literacy. Two aspects of the computer use—software and a sign-up book management strategy—demonstrated positive results related to children's emergent literacy development. Classrooms used numerous story-based software programs (e.g., *Harry and the Haunted House*, *Dr. Seuss's ABCs*, *Just Grandma and Me*, and many Living Books software programs) whose interactive features helped children understand such literacy concepts as words are read from the top of the page to the bottom and from left to right; words have meaning and are used to tell stories; words tell stories about pictures; stories have characters, actions, settings, and sequence; and stories have a beginning, middle, and end.

Hard copies of the computer storybooks were always placed near the computer. Field notes and videotapes from classroom observations show children reading the hard copy of the book while interacting with the story-based software. Often one child operated the mouse while another found the pages in the hard copy and followed along. At times the mouse operator used both the book and the software and compared what was happening on the book's pages to what was happening in the story on the computer's monitor. Children pointed to the words in the book while the computer highlighted words on the monitor, or they pointed to the words as the computer highlighted them. Often children clicked again and again on a particular word to hear its pronunciation. At other times, children simply took the book to the reading center and settled in with it, "reading" the pictures, retelling the story in their own words, or repeating aloud what they had memorized from hearing the story read by the computer.

A sign-up book for managing the computer center also demonstrated that children's writing was going through typical stages of development. Children were required to sign up to use the computer, a strategy that has been proven effective both for management at the computer center and for studying the stages of children's writing (Godt, Hutinger, Robinson, & Schneider, 1999; Hutinger, et al., 1998). The sign-up books had blank pages, one for each day. The children quickly caught on to using the book to "sign" their names to schedule their own time at the computer. While most children's signatures were scribbles, children were surprisingly adept at recognizing whose "signature" was next on the page. Although all children did not form actual letters, they made symbols that others learned to identify.

Children's signatures were photocopied from the sign-up books; one signature came from the a book at the beginning of the year and another signature from a book at the end. Fifteen pairs of signatures were randomly selected then distributed blind to seven members of the Macomb Projects' staff who worked with technology and literacy projects. They were asked to identify which signature of the pair came from the beginning sign-up book and which came from the end. They identified 75% of the final signatures. This suggests that at least some of the improvements in children's writing were stimulated by the computer sign-up books since they were used on a daily basis and since children had few other opportunities for writing in the classrooms.

Fine motor and tracking skills. Occupational Therapists at Just Kids found the computer was a "very motivational tool." The O.T.s used a touch screen attached to the computer's monitor to work on prehensile skills. Children were given a small peg, instead of the long stylus. One O.T. explained:

> ...the children grasp the peg in their finger tips verses a more immature holding grasp [to work] on that vertical computer screen... Using the touch window puts the hand in a wonderful position. It uses wrist ability, wrist extension, and it helps the stability of that wrist because working on a vertical plane helps promote tripod grasp and these are all skills that carryover into writing. When kids need to do academics, table top activities, we can transfer those skills using the stylus or the small pegs on the computer, down to more table top activities.

The therapists also used the computer to work on visual motor skills. Children would watch, especially in drawing programs, how the lines moved across the screen. Using the drawing programs, explained an O.T., allowed her "to work with children on verticals, horizontals and circular scribbles." She went on to explain:

> We also use a lot of computer programs that [the Tech Team] has given us to work on specific visual and perceptional skills, like facial relations [and] object/form

constancies...some of those activities are boring to do—repetition on table top, just using puzzles... things like that. However, the computer really gives them a unique way to engage, yet still learn these very important visual/perceptional skills which carry over to academic activities. Also, we can use a lot of computer activities for eye/hand coordination...they can organize in sequence using the mouse to click on different parts. They can follow the directions to find different shapes and objects and can sequence that while they are clicking and moving the mouse at the same time.

Progress noted by teachers and families. Phone interviews with families and teachers supported the observational data patterns showing that children's learning improved as a result of ECCTS. Thirteen parents whose children were in the project during Year 3 agreed to participate in phone interviews. These parents were questioned concerning improvements they had observed in their children since beginning ECCTS. See Table 4. Results demonstrate that all parents saw improvements in their children across a variety of areas.

Table 4. Results of Phone Interview with 13 of the 15 Year 3 Parents and 14 Study Classroom Teachers (8 Special Education, 6 Early Childhood) Regarding Improvements Noted in Children as a Result of Their Involvement in the ECCTS Classrooms

	Yes		Maybe		No	
Improvements	**Parents**	**Teachers**	**Parents**	**Teachers**	**Parents**	**Teachers**
Playing with Others	12	14	0	0	1	0
Language Development	13	14	0	0	0	0
Learning in a Different Way	12	14	1	0	0	0
Performing Independently	10	14	2	0	1	0
Building Self-confidence	12	14	1	0	0	0
Problem Solving	9	14	2	0	2	0
Exploring New Ideas	11	14	2	0	0	0
Understanding Cause and Effect	7	14	5	0	1	0
Socializing and Turn-taking	13	14	0	0	0	0
Focusing Attention	11	14	2	0	0	0

Interviews with family members also provided evidence that technology positively affected children's lives. The mother of a child with multiple disabilities was excited about technology's impact on her daughter's opportunities for socializing and communicating:

> It has made her come alive. Just having her on the computer made her feel just like the other kids. She would be in with typically developing children and was the most involved in the class. It was a thrill to me and my family to see her at the computer. The other kids would be gathered around. They would be helping her and watching her. She learned to take turns, which is a big thing... She is also visually impaired. It was exciting because you could see her eyes light up when she was looking at the screen. We don't know how much she is seeing, but she's seeing something. [Technology] is helping her come out of her shell...she is socializing with other children. I think that was such an important thing—to feel she is part of the group. It's just another way for her to communicate because [communication] is so difficult. It is also carrying over at home. She is communicating with her brother who is 8 years old. He is starting to understand her abilities. Everyday is a new thing for the two of them. He's saying, "Hey, she can talk to me.' or 'She can play like my friends' brothers and sisters." Even though it is different, he is excited about it. It is great and wonderful.

Interviews with 14 Year 3 classroom teachers yielded similar results. Table 4 also indicates that 100% of the teachers interviewed saw improvements in the children in 10 areas, including attending, socializing, and language development.

Summary. Findings from classroom observations and other data sources listed in Figure 5, demonstrated that computers and accompanying software, when employed according to the ECCTS model, were very efficient, compared to other classroom activities, in promoting (a) attending and engagement, (b) fine motor skills, (c) visual motor skills, (d) emergent literacy, and (e) communication. Children increased in social skills, including sharing and turn taking, and self confidence. While children were at the computer, aggressive behavior decreased.

The Director of Educational Programs at Just Kids summarized the benefits of computer use: "...children not only learned how to socialize with one another with their use of the computer but how to negotiate whose turn it was, signing in for the computer [and] problem solving when someone jumped their turn...[The computer] enhances socialization skills. That's something that I never thought would be possible."

Policy

At the time the ECCTS study was conducted at Just Kids, responsibility for special education in New York was divided into three parts. Children from birth to three were in programs organized through the state and county Boards of Health. Preschoolers, ages 3 - 5, were the responsibility (not fiscal) of the local school districts, but decisions regarding eligibility were the province of the Committees of Preschool Special Education, composed of Board of Health representatives from the county in which the child resided. All others, kindergarten and higher, were the responsibility of the local school districts and their Committees on Special Education. At each of the three levels, IFSPs or IEPs were drawn up and recommendations for services were made within the committee.

ECCTS studied policies' impact on children's transitions in regards to technology. At the time of this study, a draft of state policy regarding assistive technology was in its ninth revision. Problems resulting from the lack of written policy were (a) the use of multiple IEP forms which were not equivalent for all children since each district developed its own; (b) lack of communication of important information among agencies and service levels; (c) confusion in parents' minds about procedures which varied from year to year or setting to setting as their children grew older; and (d) the unpopularity of writing technology recommendations into IEPs. This reluctance to include assistive technology recommendations in the IEPs may have stemmed, in part, from the school district of residence having to pay for the service or equipment that was recommended.

The study of policy and its effect on ECCTS' goals and outcomes included a review of the literature, analysis of existing and subsequent policies and their effects on implementation, information exchange, and consultation. The primary documents examined for policy information were the *Guidelines on Assistive Technology Devices and Services to Students with Disabilities, Ages 3-21: A Planning and Implementation Manual for Educators and Providers in New York State* (1998) and the *Updated Regulations of the Commissioner of Education, Part 200, Students* *with Disabilities* (1998). Policy findings from the other four 180U collaborative projects that received federal funding at the same time ECCTS was funded were also of interest.

Maintenance of a Comprehensive Technology System

In conjunction with findings from the other four 180U collaborative projects, analyses of the documentation of ECCTS' progress led to conclusions about maintaining a technology system:

- Implementing and maintaining a technology system within a school is more likely to occur when the program begins on a small scale involving teachers who agree to participate.
- Teachers' acceptance of technology tends to lead toward maintenance of a technology system.
- If technology integration is to succeed, teaching staff should be involved in planned, on-going, hands-on training by expert trainers who understand the potential of technology, the needs of children, and the characteristics of adult learners.
- Continuity in technology activities and integration into the regular education curriculum are strengthened when teachers request technical assistance and receive timely and helpful responses.

As the Just Kids' Tech Team's technology skills improved, they provided continuing on-site curriculum and technical support to teachers. Tech Team members assisted teachers as they learned new skills, guided them through technical difficulties with hardware and software, helped them develop plans for using software to support curricular goals and for integrating a concept introduced by software, and supported teachers by helping them create adaptations for children with more severe disabilities. The Tech Team members went out of their way to provide training opportunities at convenient times for teachers.

The Macomb Projects' trainers as well as the Just Kids' Tech Team used interviews, observations, transactional evaluations, and purposeful discussions to keep in touch with the feelings of participants as they learned and used technology applications. The trainers' attention to learners' perceptions promoted dialog about teachers' apprehensions and led to effective use of what was learned. Hands-on training and timely technical assistance from the Tech Team alleviated initial fears about using the technology and encouraged teachers to experiment. Teacher satisfaction with the training and their own integration of technology were positively influenced by regular feedback about their progress, open communication among teachers and Tech Team, as well as information from Macomb Projects regarding the ECCTS evaluation results.

Data from analysis of observations, from interviews with the teachers and administrators, from transactional evaluations of teacher attitudes and concerns, and from interviews with Macomb Projects' staff demonstrate that the technology system implemented by ECCTS did not conflict radically from Just Kids' existing values, systems, or codes of behavior. As a result, the project was accepted by both administration and classroom teachers. It expanded to other classrooms when teachers who were not participating in the study heard about the training and technology's benefits for children. These factors enhanced the maintenance of the ECCTS system after the project ended.

Lessons Learned

1. Technology assists in inclusion of children with disabilities in regular settings when teachers are trained, when appropriate equipment and plentiful software are available, and when software is targeted to meet the specific needs of individual children. Technology provides access to activities in the general curriculum.

2. Staff must be involved in planned, ongoing, hands-on training by expert trainers who understand the potential of computers, the needs of young children, and positive elements of adult learning. Time scheduled for this training is crucial to success.

3. Training, follow-up, and reliable, timely support by an on-site Tech Staff contribute to teachers' computer use.

4. Teachers require time and support to adequately establish and implement computer curriculum integration in their classrooms.

5. Technology implementation is more successful when administrators encourage teachers' technology use by providing equipment, software, training, and opportunities for on-going technical support.

6. When teachers integrate appropriate computer software and adaptations into the early childhood curriculum and set up accessible computer centers in the classroom, outcomes are positive for children across a wide range of disabilities.

7. Successful adoption of an innovative model depends on the flexibility of the model and the latitude it provides for modifications. Flexibility allows a school to make the model its own and incorporate it into the culture of the school.

8. Policy can help or hinder a child's opportunity for access to appropriate special education services and assistive technologies.

Implications for Practice, Policy and Future Research, including Recommendations for OSEP

The first recommendation emanating from our experience with ECCTS, then with the project's replication in a Steppingstones III project, is to provide incentives for others to adopt effective research-based models. Incentives might be financial, as shown in the spring, 2000 OSERS RFP for adoption of research in public schools. Incentives should be based on the degree of efficacy the research demonstrated in solving particular problems faced by educational institutions. Incentives might also include community, state, regional, and national recognition for successful adoptions and/or replication.

Pay more attention to the dissemination phase of research and model development projects by providing greater federal and state support. Researchers might benefit from greater emphasis on workshops presenting a variety of dissemination modes and networking opportunities during the Project Directors' Meeting in the summer. We must find different ways to disseminate information about research models, to 'get the word out,' to a nonacademic audience at various levels, beginning with grass roots communities. Scholarly articles and research presentations at professional meetings, while important for providing information to other researchers, are seldom read or heard by teachers and parents unless they are enrolled in university coursework. Spotlighting 'Ideas That Work' to the public in short segments in various media, including the Internet, would be useful. Although the strategies sound less than professional to researchers, perhaps adaptations of the Child Find procedures used in early childhood programs (i.e., announcements on grocery store bulletin boards, information in beauty shops and doctors' offices) would uncover some successful dissemination modes.

We recommend that greater attention be paid to examining the results of using computer technology with young children over time. At the present, a backlash against young children using technology is afoot. Although the arguments used are not founded in research, the concept is appealing for several reasons, including cost.

If we expect to move the results of research that works into teachers' classrooms, we recommend that research be conducted in 'real world' contexts, in collaboration with teachers and staff. Then we must present it in terms and venues that do not elevate research to the imaginary, but elite, "ivory tower" of colleges and universities. Qualitative research design allows study of the effects of technology (and other factors) in the "real world" and should be continued. A combination of qualitative and quantitative strategies will strengthen studies. While isolating a particular factor and carefully manipulating it may be necessary in medical research on the effects of drugs, or in agricultural research on varieties of seeds, it is not possible to manipulate children, families, teachers, and schools in this way for a continuing period of time. Almost everything happens at once and in interaction with other factors in the real world of preschool classrooms and in families. Teachers and school administrators know this. So do families. Our research paradigm should expand to reflect this milieu.

Place greater emphasis on administrative commitment to provide instructional leadership in future funding and grant-related activities. Continue emphasis on the benefits of technology with all age groups in interaction with decision makers in communities, states, and federal levels.

Establish a follow-up mechanism to provide ongoing contact and a variety of incentives for original research sites in order to maintain an innovation. The mechanism should include simplified evaluation and comparisons to original findings.

Encourage schools to plan for and provide long term commitment to establishing an innovation, both in terms of time and budget. It took three years for ECCTS to successfully get to the point where institutionalization occurred. It did not happen in a year nor did it happen without ongoing training and support. There were ups and downs. The collaboration between university and school was useful. Each learned from the other. Such collaborations should be encouraged by state and federal funding entities.

Study ways to make systemic changes in administrative budgeting. Budget issues must be addressed so that technology will not be viewed by schools as an add-on that increases budgets. Budgets should allow not only for equipment purchases but also for software and staff development. All three constitute necessary expenditures for successful technology implementation. We must demonstrate that expenditures for technology will replace expenditures in other traditional line items, so budgets do not reflect both a technology strand *and* a strand of existing line items. If technology helps learners do things differently, then some prior budget items can be decreased or eliminated. That is not to say that computers will eliminate books, or music, or art, or even personnel, although readjustment of traditional modes of operation may be studied.

Continue to establish and maintain working groups of related research projects at the federal level, headed by a knowledgeable consultant. Working as a group with the other 180U projects was extremely useful. It started from the beginning of our work and carried throughout the funding period, and into a shorter summative, coordinative phase. Such work should be continued because it builds trust and furthers collaboration among researchers. It also makes it possible to corroborate findings across different locations and populations. Moreover, such collaborative work forms a strong research base among participants that can be continued across time. ECCTS' mixed methods qualitative and quantitative approach produced findings that will suggest further research to the reader. Many ECCTS findings were supported by observations and data from the other projects. A review of such evidence is useful to the field.

Establish more effective state and local policies regarding technology, policies that go below third grade down to preschool. We find that the reality of policies is to protect the school district from spending money on assistive technology and to maintain subtle rules (or lack of them) that restrict technology applications from being included in IEPs. Policies should include team-based technology assessment for children who are unable to access the environment and curriculum without technology. The technology assessment may be part of a comprehensive assessment or may be a stand alone piece. Additionally, the issue of successful transition from preschool to public school programs such as kindergarten, is closely related to the policy issue.

Develop and study a streamlined technology assessment for young children, together with a technology "screening." TTAP's procedures, while thorough, take a great deal of resources and staff time, and could probably be effectively shortened.

Early childhood programs should not only be provided with current hardware and software, but must also provide staff training on using appropriate, interactive software focused on children's everyday experiences. The children and staff in ECCTS were able to use the most up-to-date equipment and software for schools, a factor that made life easier for all, including the Tech Team. Little time was spent in trying to get older equipment to work, a condition that eliminated a great deal of frustration, and allowed current, interactive software to be used. Although foundations are able to get tax write-offs for donating used computers to schools, a balance between that activity and providing useful, powerful current equipment with such "gifts" must be carefully appraised. Young children and their teachers should not have to use older generations of hand-me-down equipment when access to powerful equipment allows applications that are likely to lead to the acquisition of higher order cognitive skills, including decision making and problem solving.

Further research is needed to study the effects of software on child outcomes to determine the differences among computer programs used in early childhood programs. Are there advantages to software that reflects a process-oriented curriculum focused on the experiences of daily life in children's homes, schools, and communities as opposed to drill and practice versions of electronic workbooks? What are the effects of content and tool oriented software that carry a high degree of interactivity? Do such programs allow a wide range of child decision making and participation?

Future work will benefit if modifications to components of the ECCTS model system are identified, evaluated, and incorporated into maintenance and replication activities. Modifications should be developed based on the culture and locations of schools.

A Tech Team must have staff development and support for their work, just as teachers do.

Tech Team members must have knowledge and skills beyond technology. At minimum the members should represent knowledge about young children, families, curriculum, disabilities, software applications, and hardware. Tech Coordinators within a school or district seldom know all those things and are probably too busy to serve as an Early Childhood Tech Team member. However, we must be careful to recognize that perhaps the concept of a building-based Tech Team is akin to the old idea that computers should be contained in a lab rather than within a classroom where children have access whenever use is needed. Nevertheless, training the Tech Team within the school was a key factor in maintaining the ECCTS system after funding ceased. It was also a key factor in moving ECCTS procedures to other sites. Schools should identify members of a Tech Team within buildings or districts. A Tech Team may take different forms, and may turn out to be one person within a school but with team membership crossing several schools.

And finally, we would use the term "access technology" (we heard it first used by Sue Mistrett from Buffalo, New York) rather than assistive technology, a label which carries with it the idea that since the individual isn't "perfect" then some kind of technology is necessary to assist the individual. "Access" applies to all individuals, whether or not they are disabled.

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Appendix A

Principles Related to Establishing and Maintaining an Effective Early Childhood Comprehensive Technology System

Principle 1 (Requirements for the system)

Implementing and maintaining an Early Childhood Comprehensive Technology System (ECCTS) requires four components: ongoing staff training, technology assessment, a developmentally appropriate curriculum that integrates technology with general education activities, and effective transition procedures.

Principle 2 (Efficiency of tested models)

Basing a comprehensive early childhood technology system on tested early childhood model components provides advantages that include immediate start-up, minimal investment of time in materials and procedure development, as well as a foundation to make modifications.

Principle 3 (Training and Support)

Successful implementation and maintenance of a comprehensive technology system is sustained by ongoing staff training and support at two levels:

(1) an experienced and successful internal or external training organization (in ECCTS, this was provided by university level technology trainers) and

(2) an on-site Tech Team.

Principle 4 (On-site Tech Team Roles and Characteristics)

Within a site, a well trained, effective Tech Team provides training and leadership which contributes to maintenance and continuation of a technology system. An on-site Tech Team provides technical support and identifies and solves simple technical problems related to hardware and software. Team members are readily available and patient. They possess good listening skills and continually update their own technical, early childhood, and special education knowledge and skills. The Tech Team also provides information and guidance to parents.

Principle 5 (Teacher knowledge and skill)

Effective technology use in early childhood classrooms containing children with disabilities depends on professional staff knowledge, skill, and comfort related to equipment, adaptations, and software for both themselves and young children.

Principle 6 (Successful implementation and maintenance)

Implementing and maintaining a technology system within a school is more likely to occur when the program begins on a small scale involving teachers who agree to participate. Teachers' acceptance of technology tends to lead toward maintenance of a technology system. The staff observe benefits for themselves and for the children. Expansion into other classrooms is more likely as positive interactions occur among personnel who see the benefits of technology. Implementation and maintenance is more likely to occur when the technology system does not conflict radically from existing values, systems, or codes of behavior and when it has strong administrative support.

Principle 7 (Increase in children's positive growth)

When teachers integrate appropriate computer software and adaptations into the early childhood curriculum and set up accessible computer centers in the classroom, young children across a wide range of disabilities increase in social skills including sharing and turn taking, communication, attention, self confidence, fine motor skills, emergent literacy, visual-motor skills (tracking), and greater self-esteem.

Principle 8 (Evaluation)

Ongoing evaluation of teachers and children increases the chances of the success of technology incorporation into an existing program.

Principle 9 (Effects of transition)

When preschool children make the transition into public school kindergartens, the substantial gains children made while using technology in the preschool classroom are diluted, even lost, unless the receiving schools use the technology recommendations and information provided by the sending preschool.

Principle 10 (Policy)

External policies at the state and district level often conflict with and inhibit a school's ability to implement and maintain an early childhood comprehensive technology system.

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