Functional Problem Solving Skills for Children with Pervasive Developmental Disorders

FINAL REPORT

Grant # H024B60120
U.S. Department of Education
October 1, 1996-September 30, 2002

December 31, 2002

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I. Background

A. Pervasive Developmental Disorders

According to the latest Diagnostic and Statistical Manual of Mental Disorders (American Psychiatric Association, DSM-IV, 1994), the Pervasive Developmental Disorders (PDD) include Autistic Disorder (onset prior to 3 years), Rett's Disorder (onset of symptoms between 5 and 30 months), Childhood Disintegrative Disorder (onset between 2 and 10 years), Asperger's Disorder and PDD Not Otherwise Specified (PDDNOS), which includes Atypical Autism. The DSM diagnostic categories and criteria have changed repeatedly over the past three versions as research has proliferated, causing considerable variation in the use of the PDD labels, and resulting in an unclear picture as to actual incidence. Incidence has been variously estimated at from 1 per 300 children to 4-5 per 10,000 (Volkmar & Cohen, 1986). Boys with PDD outnumber girls by 3 or 4 to 1 (Volkmar & Cohen, 1986), although Rett's Disorder has been identified almost exclusively in girls (Tsai, 1992). There is relatively little research on young children diagnosed with PDD, and most of the research cited below involves children labeled autistic, who are generally school aged.

B. Cognitive Skills of Children with PDD

There is no doubt that attention to the cognitive skills of children with PDD has lagged far behind that paid to their social-communicative skills. Initially, diagnostic criteria for PDD related strictly to impairments in social/communication skills, but by DSM-III-R (1987) the criteria included "markedly restricted repertoire of activities and interests", which by DSM-IV (1994) was expressed as "restrictive, repetitive and stereotyped patterns of behavior, interests and activities." Although it is now accepted that PDD is characterized by cognitive as well as social skill deficits, the bulk of intervention efforts have addressed social skills (e.g. Kirchner, 1991; Hamilton & Snell, 1993; Trad, Bernstein, Shapiro & Hertzig, 1993; Fine, Bartolucci, Szatmari & Ginsberg, 1994; Taylor & Harris, 1995).

The cognitive abilities of children with PDD are often difficult to assess. On the one hand, children who have not acquired speech and do not respond to verbal input are virtually impossible to test given the readily available instruments. These instruments rely upon verbal input and output, and also confound verbal and cognitive development, so that the child without verbal skills tests very low. Another difficulty in evaluation lies in the fact that assessments of cognitive abilities are notoriously weak in terms of their functional properties. Children with PDD may perform well on rote sorting and matching tasks typical of such assessments, but fail to perform similar tasks in more functional contexts. Despite clear skills in certain object relationships, it is common for children with PDD to exhibit limited functional skills in terms of specific object interactions and a tendency to engage in stereotypical, self-stimulatory or nonfunctional actions on specific objects.

Two major lines of research on functional cognitive skill development have revealed delays in children with autism. The first line involves performance on certain Piagetian tasks. Sigman & Ungerer (1981, 1984) determined that the functional and symbolic uses of objects by children with autism were deficient as measured by Piagetian classification tasks, although they were able to categorize objects on the basis of perceptual cues and spatial relationships. Ungerer & Sigman (1987) found that children with autism could sort according to perceptual characteristics of objects as well as MA-matched children with mental retardation. However, they had more difficulty sorting objects according to their function. Sigman, Ungerer, Mundy & Sherman (1987) found that the functional play of children with autism was qualitatively different from that of MA-matched children and included less symbolic play. Kasari, Sigman & Yirmaya (1992) found less exploration of objects by children with autism, although it increased in structured conditions involving active encouragement by adults. Shulman, Yirmiya & Greenbaum (1995) compared the performance of children with autism, children with mental retardation and children without disabilities using free-sorting, matrix and class-inclusion tasks. Those with autism performed worse than the other two groups in class-inclusion tasks and free-sorting of representational objects, tasks which involve the internal manipulation of information. Yirmiya proposes that a global cognitive deficit is present in children with PDD that affects operations on both the animate and inanimate environment, preventing internal manipulation of information about the environment. (Yirmiya, Sigman, Kasara & Mundy, 1992).

The ability to imitate is another aspect of cognitive development that has been studied in children with autism. A criterion of "no or impaired imitation", present in DSM-III-R (1987) had disappeared from DSM-IV (1994), even though atypical imitative behavior has frequently been noted in the population. Spontaneous imitation is rare in children with autism (Sigman, Ungerer, Mundy & Sherman, 1987) and under experimental conditions designed to encourage motor/gestural imitation, performance is poor compared to MA-matched children (Curcio, 1978; Dawson & Adams, 1984; Sigman & Ungerer, 1984; Jones & Prior, 1985; Ohta, 1987). On the other hand, individuals with autism are often noted to engage in functionless imitation of verbal input, or echolalia (Rutter, 1979). Meltzoff & Gopnik (1993) theorize that the imitation of gestures requires a level of perspective-taking that is difficult for individuals with autism and that is not required in order to imitate speech. Learning through observing and then imitating the behavior of other people is a primary learning strategy for young children, and the absence of spontaneous motor imitation is a serious barrier to learning. In the words of Sigman, Ungerer, Mundy & Sherman (1987), "Autistic children seem tremendously impaired in their ability to learn from other people and about other people" (p. 115).

C. Need for Research and Demonstration on Cognitive Development

Cognitive skills in general have received uneven attention across recent curriculum and assessment efforts. In many curricula, cognitive skills *per se* have been ignored. Other curricula target cognitive skills without reference to their functionality, as exemplified by meaningless matching and sorting tasks. A welcome instructional trend has been the development of functional curricula that integrate the training of basic skills across functional daily routines. However, cognitive skills have not been so readily absorbed into the notion of functional curricula. Those few functional curricula that do accommodate cognitive skills are not appropriate for children without verbal skills who may experience mental retardation. Finally, curricula developed for children exhibiting overall developmental delay are not necessarily useful for children who exhibit an uneven and inconsistent pattern of skill levels.

It is important to note that none of the research described above features assessment in "natural" or truly functional contexts. Furthermore, most of the tasks used to assess cognitive abilities are ones that require the subject to use and/or understand language. Thus, the applicability of the results to young children with PDD is questionable in many cases. Certainly this body of research accomplishes little in terms of describing the typical functioning of children with PDD in their school and home environments. Nonetheless, it is obvious that the identified difficulties in understanding the functional uses of objects and in learning from observation have a serious impact on successful interaction with the physical environment.

Mastery of the physical environment means that one can interact effectively with the inanimate environment. That is, one can initiate actions on objects, materials, equipment, and spaces and can respond appropriately to the opportunities, problems and demands that these aspects of the physical environment present. The skills that allow a child to master the physical environment are the cognitive skills necessary to understand the uses of objects, the relationships between objects and actions, ways to gain access to objects and how to use objects in a group situation where they may mediate social interactions. Success in play and daily living depends to a large extent on the individual's understanding of the physical environment.

When we think of cognitive skill development we often think of Piaget (1952, 1971, 1974) and the object manipulation tasks that he used as evidence of simple and advanced mental processes ranging from "primary circular reactions" (e.g., visual tracking of moving objects) to "invention of new means through mental combination" (e.g., using a stick to bring a desired object within reach). Mastery of the physical environment requires the ability to solve a wide range of problems, from concrete ones such as how to get into the house when you've locked your key inside, to abstract ones involving linguistic, mathematical or scientific constructs. The solution of any problem in the physical environment requires certain basic cognitive skills including memory, categorization, discrimination, predicting the outcome of behavior, and the knowledge that an indirect means to an end (e.g., using a tool or circumventing a barrier) may be more efficient than a direct one (e.g., attempting to break directly into a container or directly through a barrier). The more abstract object interaction tasks require symbolic reasoning and mental imagery that are probably beyond the abilities of many children who have severe disabilities, some of whom may never acquire an abstract language system. But the solution of concrete problems -- problems that involve the manipulation of objects and that require a minimum of symbolic mediation -- are within the grasp of many of these children, assuming that they are sufficiently interested in finding a solution. For instance, one problem that any child might face occurs when a ball rolls out of reach under a chair. This problem may be solved in a number of ways: the child might use a stick as a tool to coax the ball out from under the chair; she might go behind the chair and find the ball easily reached from that side; or she might seek out the help of another person. These solutions may seem mundane and obvious--yet for many children with severe disabilities they are not.

Object interaction skills are generic skills -- they are tools that may be used to solve new problems as they appear in new situations or with new materials. They are skills that increase the user's independence and ability to adapt to the changing parameters of a normal lifestyle. Children with PDD must function in integrated home, school and community settings, and they are faced with constantly changing and expanding environments. They need to have the tools to tackle the concrete problems posed by new situations, rather than erupting into "challenging behaviors" or waiting passively for problems to be solved for them.

D. Object Interactions Reflect Cognitive and Social Skills

Children who can speak and understand speech or who can read and write can demonstrate their cognitive abilities by solving problems presented verbally. Children who are very young or who have significant disabilities may not be able to demonstrate the true extent of their cognitive skills through verbal responses. The skills that allow children to negotiate the physical environment include the cognitive skills necessary to understand the uses of objects, the relationships between objects, relationships between the self and objects, and ways to gain access to desired objects. These interactions with objects imply certain cognitive processes and can serve as a window onto children's cognitive abilities. In other words, children's interactions with the physical environment reflect their understanding of the world and how to use the physical world to achieve their own ends.

As we view the world of the typical young child, we also realize that objects serve an important role in social interactions. Objects can mediate social interactions such that the ability to interact with objects may provide a key to the successful socialization of the young child. It has also been demonstrated that both the object interaction skills appropriate to social contexts and the accompanying social skills can be taught (Gaylord-Ross, Haring, Breen, & Pitts-Conway, 1984). Increasing the child's exposure to and interest in objects that also interest his peers may improve the chances of acceptance by those peers in social settings (Hurley-Geffner, 1995). In other words, if the young child with PDD learns how to interact with objects that are typically used in social settings, the likelihood that he can function successfully in those contexts is greater. The fascination of a relatively nonsocial child with a certain toy or household item may attract the attention of other children who know how to initiate social interaction focusing on that item. Or, the nonsocial child may be drawn to a knot of other children who are engaged with materials that are appealing to him. Thus, a child's mastery of the physical environment has implications for social as well as cognitive development. Such nonverbal evidence of cognitive and social ability is particularly significant for learners who don't use or understand speech and who therefore can't provide verbal evidence of their own skills.

A large body of research involving typically developing infants and their object manipulation skills has explored the relationship between cognitive development and language development (e.g. Lifter & Bloom, 1989), while other research has focused on relationships between sets of specific object-related skills (e.g. Eppler, 1995; Ruff & Saltarelli, 1993). Another body of research has taken a more heuristic approach, involving the observation and categorization of children's play (Gowen, Johnson-Martin, Goldman & Hussey, 1992; Guralnick, 1981; Guralnick & Weinhouse, 1984; Tamis-LeMonda & Bornstein, 1993) or the relationship between play and problem solving abilities (Rubin, Fein & Vandenberg, 1983; Vandenberg, 1990). Longitudinal studies show a developmental sequence of broad categories of object relationships in children's play over time, proceeding from play involving single objects to play involving the combination of two or more objects, and from indiscriminate play to play that is guided by the unique properties of objects (Beckman & Kohl, 1987; Belsky & Most, 1981; Gowen, Johnson-Martin, Goldman & Hussey, 1992). The analysis of children's play has been described as a useful means for evaluating a child's cognitive capacities, especially in nonspeaking children (Gowen, Johnson-Martin, Goldman & Hussey, 1992; Sigman & Sena, 1993).

The play of children with autism has received considerable attention, revealing reliable differences in various parameters of play as compared to that of peers with and without disabilities. Representational and symbolic play acts have been found to appear less often in the play of children with autism than in that of children with mental retardation or in typically developing children (Wing, Gould, Yeates & Brierly, 1977; Baron & Cohen, 1987). Sigman & Unger (1984) observed less diversity as well as lower frequency of symbolic play in children with autism, although it improved in more structured situations. Interestingly, however, doll play did not respond to adult encouragement. Sigman & Sena (1993) comment "Play …may be practically useful for identifying the symbolic competence of a child, particularly one who is reluctant to speak to or in front of an unfamiliar adult." (p. 38).

E. Our Previous Research

Some years ago we concluded research on the cognitive skills revealed by children with deafblindness as they interacted with the physical environment. Assessment and training procedures developed through that project (Rowland & Schweigert, 1997a and b) proved successful in terms of student outcome and were "user-friendly" for teachers and parents. Two assessment instruments were developed through that research (Rowland & Schweigert, 2001). The first is the *School Inventory of Problem Solving Skills* (*SIPSS*). This instrument specifies materials and procedures to be used to test 33 skills in three categories: Basic Skills with Objects; Ways to Gain Access to Objects; and Ways to Use Objects. Specific skills range from the most basic (such as holding two objects at one time and releasing objects) to more complex skills (such as constructing items and searching for items that have disappeared). The second instrument is the *Home Inventory of Problem Solving Skills* (*HIPSS*) that was developed to gather similar data from home environments, on the assumption that many children demonstrate skills at home that are not seen at school. Teachers and parents who have used these instruments value them for their clear relevance to performance in typical activities and for their applicability for children without verbal skills and for children with vision impairments. In contrast to other scales and subscales designed to measure cognitive development, these instruments do not confound cognitive, sensory and verbal abilities. Furthermore, they suggest concrete intervention targets that may be incorporated into regular classroom and home activities.

F. Parallels with Children who have Sensory Impairments

It is legitimate to question whether procedures and materials developed for children with multiple or sensory impairments and severe mental retardation would be useful for children with PDD. Both our own experiences and those of others (Stillman, Mar, personal communication) suggested that this was a promising prospect. Children with PDD, like children with sensory impairments and mental retardation, are likely to be unresponsive to verbal input, are likely to have severely impaired expressive communication skills; are likely to be unable to learn from observation (and unlikely to engage in motor imitation); may be prone to echolalia; engage in self stimulation and stereotyped actions on objects; and may have severely restricted repertoires of object related skills. Burd, Fisher & Kerbeshian (1985) found a high incidence of multiple disabilities among a sample of children labeled PDD, while Goodman & Minne (1995) found among congenitally blind children a high incidence of PDD. Instruments developed for measuring the abilities of children with autism have been used to evaluate children with deaf-blindness (Kates, Schein & Wolfe, 1981).

Needless to say, children with PDD also demonstrate striking contrasts to children with deaf-blindness, and that is why the materials developed for the one population were not assumed to be directly applicable to the other. Children with PDD are likely to demonstrate a lack of interest in or attachment to other people and they are likely to show widely fluctuating performance levels.

A small study of six young children with PDD (three in Portland, OR and three in Dallas, TX) was conducted, using the *HIPSS* and *SIPSS* developed for children who are deafblind. These assessments revealed large deficits in the object interaction skills of these young children with PDD. Of the 33 skills measured, only 11 were observed by classroom teachers to be exhibited by more than 50% of the children. That is, for 22 of the 33 skills, three or fewer of the six children demonstrated those skills. These 22 skills included Holding Two Objects at a time, Transferring Objects from hand to hand, Searching for Objects, Opening Containers, Using Containers to Carry Objects and Using Simple Tools. Across these six children with PDD, the mean percent of skills demonstrated out of the 33 skills was 44%. This is the same mean score obtained prior to intervention by children from our earlier project who had significant vision and hearing impairments, severe mental retardation and, in some cases, orthopedic impairments.

II. Project Goals, Instructional Model and Materials

A. Project Goals

The major goal of this project was to adapt the assessments and instructional materials that we had developed for children with deaf-blindness to address the needs of young children with PDD. Instructional strategies developed through this project were to be ones that would generate explicit methods for incorporating object interaction skills into regular classroom activities. The environmental contexts that seem to enhance and suppress performance in children with PDD were analyzed in an attempt to document clear strategies for adjusting the learning environment to the fluctuating needs of individual children with PDD. This project demonstrated how to encourage the development of object interaction skills in children with PDD in the context of regular classroom activities so that teachers would learn how to adapt typical classroom activities and routines to provide learning opportunities for the child with PDD. The opportunities targeted were ones that would encourage independent behavior and the initiation of object interaction by the child and that would be applicable to other children in the classroom.

This project was funded specifically to examine the cognitive abilities of young children with PDD as revealed through their interactions with the physical environment. We know, however, that socio/communicative skills are an area of great need in all children with PDD, and we had previously conducted extensive research on the development of communication in young children with significant disabilities, including

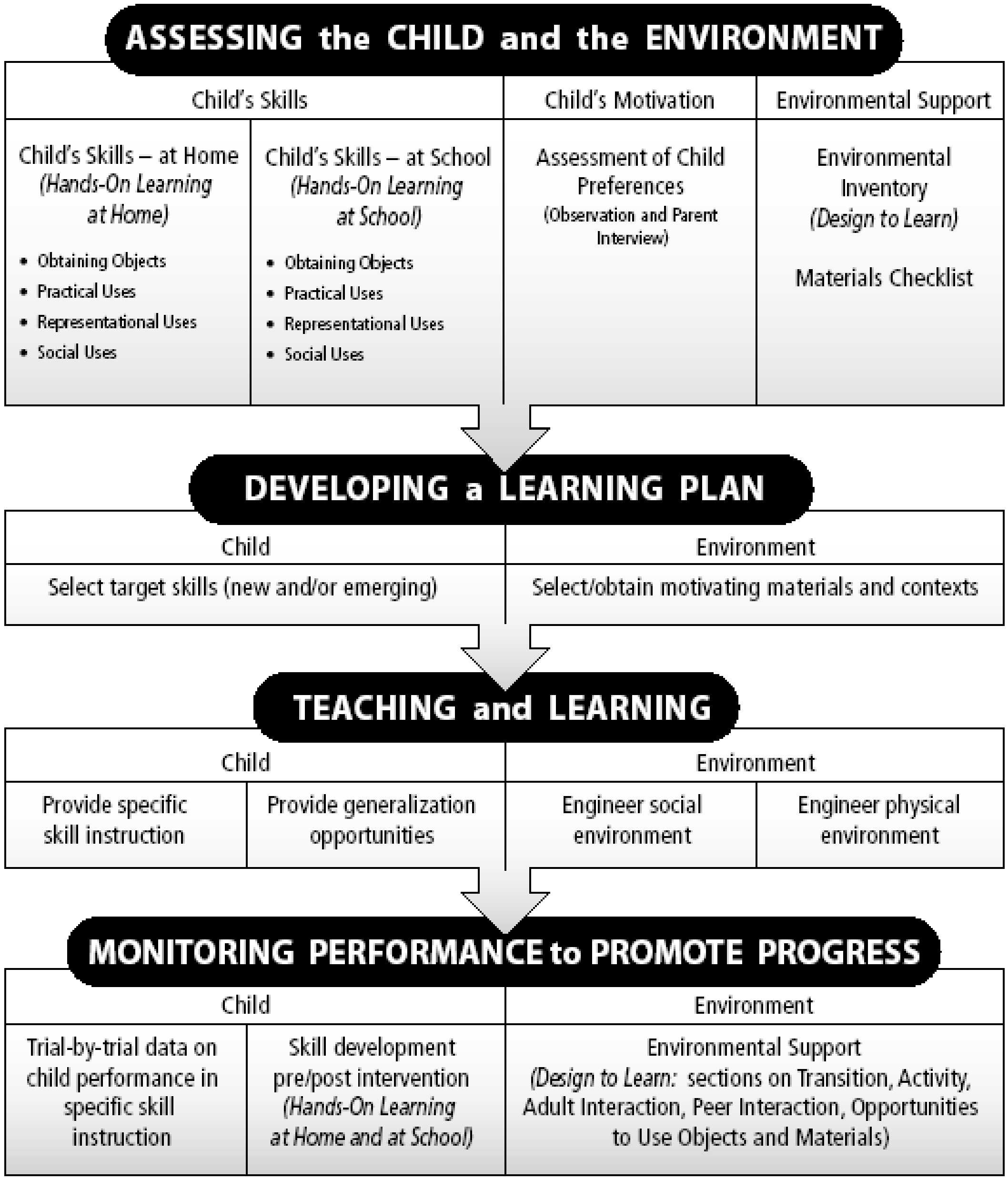
PDD. As this project unfolded, we found that one of the major benefits of paying close attention to the object interaction skills of children with PDD was that developing strengths in the realm of mastering the physical environment might also be used as a basis for promoting social interaction between the child with PDD and his or her peers.

B. The Hands-On Learning Model

In this section we briefly describe the model that has been developed over the course of the project. It is explained more fully in the Teacher's Guide appended to this report.

Our model is presented graphically in Figure 1. This model includes four major components: Assessing the Child and the Environment; Developing a Learning Plan; Teaching and Learning; and Monitoring Performance to Promote Progress. Major features of the model are these:

- Each of the four components explicitly involves both the child and the social and physical environments in which the child operates.
- Each component is supported by materials (assessment instruments and teaching strategies) developed through this project.
- Parents are involved from the outset by providing assessment data from the home.
- There is a seamless connection between model components.
- The skills targeted in the model contribute directly to cognitive and social skill development in young children.
- The model provides support for the 1997 IDEA amendments by promoting the involvement of parents in evaluation and IEP development and by providing functional ways to collect performance data on child progress.



Model for Hands-On Learning

Figure 1. Hands-On Learning Model

C. Materials that Support the Model

The materials developed through this project include assessments of child skill (*Hands-On Learning at School* and *Hands-On Learning at Home*) and an environmental inventory (*Design to Learn*), which is used to evaluate the social and physical environments in which the child operates. A teachers' guide explaining the model and related materials and strategies was also developed (*Hands-On Learning: Guide to Assessment and Teaching Strategies*). In addition, a set of posters was developed to help classroom staff to remember to provide opportunities for hands-on learning throughout the daily activity schedule. The materials developed through this project may be used to replicate successful strategies for nurturing mastery of the physical environment in target children. The assessment and training procedures adhere to the following principles:

- They build on experiences and outcomes that are valued and meaningful from the *child's* perspective, so that they are active learning experiences rather than passive training programs.
- They are designed for use in functional life contexts in school, home and community settings.
- Multiple examples of materials are systematically incorporated into learning experiences across multiple functional contexts to build in flexibility and generalization.
- The targeted skills are ones that are easily combined or expanded upon to lead to the acquisition of new and functional skills.
- Procedures are easily implemented by teachers and instructional assistants.
- Procedures and related data systems are designed to yield a high level of performance that will be reinforcing to teachers, parents and students.

Data supporting the effectiveness of the child skill assessments and the environmental inventory are presented in Section V of this report.

1. Child Skill Assessments

Two versions of the child skill assessment were developed based on data collected during the first three years of the project: *Hands-On Learning at Home* and *Hands-On Learning at School*. These instruments are adaptations of the *HIPSS* and *SIPPS* assessments that had been developed for children with severe and multiple impairments including deafblindness. Those instruments included 33 skills organized into three strands. The final *Hands-On Learning* assessments contain 39 items in four strands. **Strand I, Obtaining Objects**, includes 12 skills needed to gain access to a desired item that is inaccessible for some reason. **Strand II**, **Practical Uses,** includes 12 skills needed to use everyday objects appropriately given their unique properties and purposes. **Strand III**, **Representational Uses**, includes 8 skills involved in understanding how one object relates to another and how objects may be used to represent concepts. **Strand IV**, **Social Uses,** includes 7 skills that involve the use of objects in social contexts and that may be helpful in facilitating social interaction. Within each Strand, skills are further organized into 14 clusters of related skills. Figure 2 shows the items included on the new assessments and how they are organized. It is important to note that the organization of the strands, clusters and skills on these assessments are largely conceptual and are not intended to imply a strict developmental progression. However, the organization was based upon the data collected from our field test of the instruments (see Section V of this report). The 39 skills are designed to be applicable for children without language (children who can neither use nor understand speech or other abstract language forms). For each of the 39 items, the instruments provide a definition, a photograph illustrating the item, as well as several specific examples. The examples are commonplace actions that might be observed at school (for the school version) or at home (for the home version). The scoring system involves three categories: Mastered (with a score of 2); Emerging (with a score of 1) and Not Present (with a score of 0). The item scores may be summed for a total score which may range from 0 to 78: the scoring profile also shows how to calculate percentage scores for each strand and for the total.

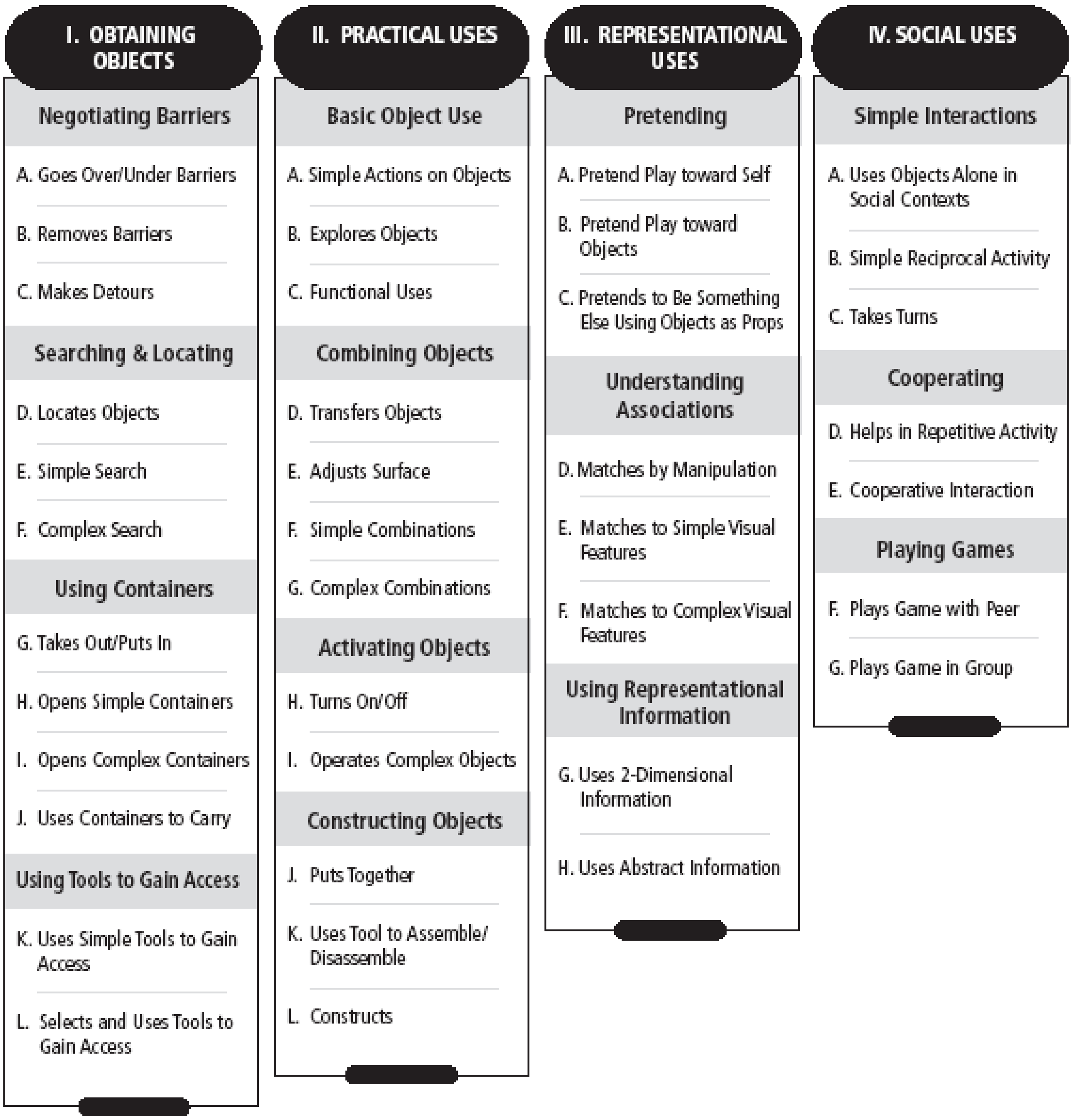


Figure 2. Organization of Hands-On Learning assessment items

2. Environmental Inventory

The other instrument developed through this project is *Design to Learn* (*D2L*). This is an environmental inventory that shows to what degree a specific activity encourages interaction with the social and physical environments for a specific child. *D2L* is an expansion of a previously developed instrument entitled "Analyzing the Communication Environment" (Rowland & Schweigert, 1993a and b). *D2L* is designed to help teachers determine to what extent a specific classroom activity encourages skill learning by a specific student.

Physical and social environments may be engineered to encourage or discourage experience, discovery, learning and mastery. A major barrier to learning is the tendency of adults (and often peers) to anticipate the child's needs, thus preempting opportunities for the child to act independently on the physical environment or to communicate his own needs and desires. If the environment does not provide learning opportunities and if it is not responsive to the child, then the child does not have a chance to learn new skills or to practice developing skills. *D2L* was developed to allow the teacher to analyze an activity for its strengths and weaknesses related to providing opportunities for the child to interact with people and objects. It provides suggestions for enhancing the learning value of activities by focusing on features of the activity that promote independent behavior on the part of the child. It increases the likelihood of independent or spontaneous behavior by aiding the transfer of stimulus control from highly contrived teacher-provided cues to more naturally occurring cues (Halle, 1987). *D2L* is administered to the environment, as opposed to the child, and the resulting scores are independent of child skill level.

D2L includes 75 items organized into eight sections: Transitions, Activity, Adult's Interaction, Communication System, Peer Interaction, Opportunities to Communicate, Opportunities to Use Objects, and Materials. Each section contains from 5 to 14 statements that describe techniques that could be implemented to encourage the child to act independently on the social or physical environments. Two of the sections involve communication. We thought it was important to include them to provide an instrument that shows how mastery of both social and physical environments may be targeted in the same activity.

3. Teacher's Guide

A booklet explaining strategies for assessing and promoting object interaction skills related to cognitive and social skill development (*Guide to Hands-On Learning: Assessment and Teaching Strategies*) has been developed. This guide describes how to implement the model and use the materials developed through the project. Key elements of the instructional approach, as explained in this booklet, are provided in Figure 3. The booklet describes the range of object interaction skills that are likely to be seen in children labeled PDD; explains how to use the assessment instruments developed through this project; describes ways to target object-related skills in classroom activities; and discusses the collection of data to monitor performance and promote progress.

4. Posters

We have developed a set of posters that may be placed around the classroom to remind educational staff to provide students with opportunities to use object interaction skills. Each of the eight posters represents a generic activity selected by teachers involved in our model and replication preschool classrooms (sensory time, structured play, unstructured play, eating, gross motor, individualized instruction, circle time, art time) and is headed by an example of how object interaction skills may be incorporated into such an activity. The body of each poster is a form listing the 39 skills from the Hands-On Learning assessments and providing spaces to indicate which skills are being targeted in a particular activity for up to three different children.

Object Interaction

Key Elements of Individualized Instruction

Assessment: How is the learner presently interacting with the physical environment?

- Assess the learner's skills-at home
- Assess the learner's skills-at school
- Analyze the environment for existing opportunities to practice these skills

Motivation: What are reinforcing topics, partners and settings for interaction?

- The materials or activities or partners are highly motivating to the learner
- Conduct a preference probe to determine the learner's interests
- Opportunities for instruction should occur regularly for consistency
- Opportunities should occur frequently enough to insure adequate practice

Teaching: What strategies will you use to assist the learner to master these skills?

- Direct Instruction for learners with limited object interaction skills may provide concentrated practice to expand their skill repertoire
- Engineer the environment to increase opportunities for the learner to develop or practice skills
- Target generalization of emerging skills to encourage mastery across a variety of objects and settings

Monitor: How do you keep track of the learners' skill acquisition and the availability of environmental supports for learning?

- Track daily performance and adjust instruction as needed to insure learner success
- Re-administer child skill assessment (SIPSS,HIPSS) periodically to note overall development at home and school
- Analyze the environment to evaluate supports for learning

Promoting Progress: How do you design instruction to promote steady progress?

- Target new skills
- Target generalization of existing skills
- Target more natural supports for learning

Figure 3. Key elements of object interaction instruction

III. Summary of Activities Conducted in Years 1-3

Years 1-3 focused on efforts to adapt the assessments that had originally been developed to address the needs of a different population. Project staff conducted specific skill instruction in those years to provide first-hand information about the object interaction skills themselves and about the abilities of young children with PDD to master them. The question of what to teach and how to teach it were the focus in those first three years.

A. Sites

Work was conducted at a Portland Public School in inner southeast Portland that housed a number of preschool classrooms associated with various community programs, including Head Start. In Years 1 and 2, we worked with four classrooms that included 10 children with PDD. Because in that first year we transferred the grant from Washington State University to Oregon Health & Science University (OHSU), we were not able to start working in the classroom until March. This left essentially three months of intervention with the original 10 children before the school year ended. In Year 2, we worked in the same four classrooms, although three of them now had new teachers. Five of our original students were still in these classrooms, and we took on three new participants. In Year 3, we consolidated our model demonstration efforts into one classroom at the same site, with a teacher who had joined the project in Year 2. (We continued to consult with and provide materials for one other teacher who had been associated with the project since Year 1.) The Year 3 model classroom combined opportunities for intensive instruction with less structured activities that included peers without disabilities. The classroom included five children with PDD, another five children with other disabilities, and three children without disabilities.

B. Participants

The primary participants were 3-5 year old children diagnosed with PDD. Project staff met with participating public school program staff to describe the project. Based on that description, teachers were asked to identify potential participants who had a diagnosis of PDD or autism and who were nonspeaking. In order to participate, their parents or guardians had to sign informed consent forms approved by the OHSU

Internal Review Board. In Years 1-3, 17 children with PDD participated in the project through the model classrooms–12 boys and 5 girls. Table 1 displays demographics on those participants.

Table 1. Demographics For Years 1-3 Participants

Child	Gender	Age	Ethnicity	Specific Etiology (if known)	Handicapping Condition*
1	F	5.7	Caucasian	Rett's Syndrome	Suspect HI SD
2	M	4.9	Caucasian	Down Syndrome	
3	M	5.10	Caucasian	CMV	SD OI Suspect HI
4	F	4	Caucasian		
5	M	4.11	African-American		Suspect VI
6	M	3.11	Caucasian		SD
7	M	4.7	Caucasian		Suspect VI
8	M	4.2	Caucasian		
9	F	3.4	Caucasian		
10	M	3.4	Other	Intrauterine drug insult	Dyspraxia
11	F	4.11	Caucasian		
12	M	5.5	Caucasian	Williams Syndrome PKU	VI Suspect HI
13	M	3.9	Caucasian		
14	F	3.11	Caucasian	Rett's Syndrome	Suspect HI OI VI SD Dyspraxia
15	M	3.9	Caucasian		
16	M	3.8	Caucasian		
17	M	3.0	African-American		

* HI = hearing impairment
SD = seizure disorder
OI = orthopedic impairment
VI = visual impairment

C. Results for Years 1-3

Compelling data were collected showing the progress of individual students with PDD as well as changes in the classroom environment. Data on the effectiveness of interventions conducted in the first three years are summarized below.

1. Cognitive Skills of Participants

Data on 17 participants are available. However, for six of these participants (as indicated on the tables) the data are based on intervention that lasted only three months or less, either because they were Year 1 participants or because they were transferred out of the demonstration classroom during the school year.

Trial-by-trial data from specific skill instruction. Table 2 shows for each participant the specific object interaction skills that were acquired in specific skill instruction. The data in Table 2 were derived from the trial-by-trial data collected by instructors as specific skill instruction activities were conducted each day. The acquisition criterion was independent performance of the targeted skill for 80% or more of the trials provided in two consecutive sessions.

Overall skill development. Table 3 shows changes in the pre-and post-intervention scores for each child using the original *SIPSS*—the object interaction assessment that was later adapted. It also shows in what strands of the original instrument gains were made over the course of intervention. Some children performed very poorly even on the original instruments designed for children who are deaf-blind. Others performed almost perfectly on the pre-test, illustrating the need to expand the original instruments to accommodate the skills of the diverse population of children labeled PDD. The post-intervention scores (available on students who were present in Years 1 or 2 only) showed improvements for all participants except for #13, who had scores of 94% at both assessments. For the higher-functioning children, improvement was slight because of a ceiling effect. These data suggested the wide disparity in object interaction skills of the participants at the start of intervention and again illustrated why we needed to make significant changes in the assessment instruments. In Year 3, a new version of the assessment was used for post tests: these scores were not directly comparable to pre-test scores.

Table 2. Skills acquired by Year 1-3 participants in direct instruction

Student	Skills Acquired in Direct Instruction
1*	Approach Object
2*	Open Simple Container Simple Search
3*	Open Complex Container
4*	Use Simple Tool to Gain Access Use Container to Carry Objects
5*	Construct/Assemble – Complex
6*	Construct/Assemble – Complex
7	Remove Barrier Open Simple Container Put In Orient Locate Simple Search Functional Use
8	Construct/Assemble Follow Picture Sequence
9	Open Simple Container Activate Simple Object Construct/Assemble – Simple Use Container to Carry Objects Construct/Assemble – Complex Follow Picture Sequence One Object on Another – Complex Functional Use Put In Take Out
10	Use Container to Carry Objects Match Shape to Template Open Complex Container Construct/Assemble – Complex
11	Construct Assemble – Complex Follow Picture Sequence
12	Go Over/Under Barrier Make Detour Simple Search Complex Search Functional Use Use One Object on Another – Simple Open Complex Container Use One Object on Another – Complex

Table 2. Skills Acquired by Years 1-3 Participants in Direct Instruction, (Cont'd)

Student	Skills Acquired in Direct Instruction
13	Construct/Assemble Follow Picture Sequence Use One Object on Another - Complex
14	Open Simple Container Remove Barrier Simple Search Take Out
15	Open Complex Container Functional Use Use Simple Tool to Gain Access Put Together Use Complex Tool to Gain Access Matches Visual Features
16	Complex Search Open Complex Container Use Simple Tool to Gain Access Use Complex Tool to Gain Access Functional Use Construct/Assemble Open Simple Container
17	One Object on Another – Complex Construct/Assemble Matches Shape to Template – Simple Visual

* Participated in 3 months of intervention or less

Table 3. Pre/post intervention scores on original *SIPSS* instrument for Year 1-2 participants

Student	***SIPSS* Pre-score**	***SIPSS* Post-score**	**Strands in which improvement occurred**		
			Basic Skills	**Ways to Gain Access**	**Ways to Use Objects**
1*	36%	Not available			
2*	32%	47%		X	
3*	67%	79%		X	X
4*	85%	88%			X
5*	79%	88%		X	
6*	77%	85%		X	
7	26%	68%	X	X	X
8	97%	100%			X
9	57%	98%			X
10	86%	98%		X	X
11	77%	98%		X	X
12	51%	77%	X	X	X
13	94%	94%			
14	36%	44%	X	X	X

* Received intervention for 3 months or less

<u>Observational data.</u> To bolster the trial-by-trial data with a more objective view of performance, monthly videotapes of specific skill instruction programs were made for each participant. These tapes were coded by research assistants who were unaware of the instructional targets. Tapes were coded on a modified frequency basis on 60-second intervals, with observers checking off the object interaction skills (from the *SIPSS*) demonstrated in each interval, qualified as attempted versus accomplished. Also recorded were cues provided by the instructor to prompt object interactions, and object interactions initiated by the student (as opposed to produced in response to a direct cue from the instructor). Inter-observer reliability on the object interaction code was computed on at least 20% of the sessions for each participant, and for each object interaction category coded. Inter-observer reliability, computed as # agreements /(# agreements + # disagreements), averaged 99% for Year 2 data. Table 4 summarizes

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the coded data collected on the six Year 2 participants for whom we had complete sets of data from monthly videotapes of their specific skill instruction. Pre-post scores represent mean scores from the first two observations versus mean scores from the last two observations across the Year 2 participants.

Table 4. Object interaction code data from monthly videotapes of Year 2 participants

Variable	Mean of First Two Observations	Mean of Last Two Observations
Mean proportion of intervals observed in which child *initiated* object interaction	.30	.52
Mean number of *accomplished* object interaction skills	2	4
Mean % of children demonstrating *complex* object interaction skills	0%	50%
Mean number of skill *clusters* represented by child object interactions	3	3.5
Mean proportion of intervals during which child *sustained* engagement in each skill observed	.12	.20

Table 4 provides five different scores derived from the observational data. The first row shows that the mean proportion of intervals that included any object interaction *initiated* by the child (as opposed to produced in response to a teacher's cue) increased from .30 to .52. The second row shows that the mean number of different object interaction skills that were coded as *accomplished* (as opposed to *attempted*) increased from 2 to 4 per session. The third row shows that the mean percent of participants who demonstrated *complex* object interaction skills increased from 0% to 50%. The fourth row shows that the number of skill *clusters* (out of 11 clusters of conceptually related skills) demonstrated by participants (either accomplished or attempted) increased from 3 to 3.5 per session. Finally, the fifth row shows that the mean proportion of intervals in which a child *sustained* engagement in any particular object interaction skill increased from .12 to .20. This is an important figure, since it suggests that the children were becoming less apt to "flit" from one object to another, but were engaging in more sustained interactions each time they demonstrated in any particular object interaction.

This data system was modified over the course of Year 3 to accommodate the expanded child skill assessments, so comparable pre-post data were not available for that year.

2. Environmental Support for Skill Development We also conducted periodic observations of the model classroom to document the demonstration of specific object interaction skills to determine which activities provided opportunities to use each skill. In Year 3, observations were made across the entire school day, and the observers noted which specific skills from the *SIPSS* were demonstrated by *any* of the students, as well as the activities in which skills were exhibited. This was a conservative measure since an opportunity was credited only if a student actually took advantage of it and demonstrated a given skill. This gave us an overall picture of the degree to which the object interaction skills had been integrated into classroom activities. Table 5 shows scores from the first of these observations made in the Fall of Year 3 and from the last observation, made in Spring of that year. These scores reflect the percentage of activities observed in the classroom during which each skill was observed to occur at least once. Skills from the first strand of this instrument (Basic Skills) are not included since all of these skills are so fundamental that they appeared in all activities. The mean percentage of activities observed that included any given skill increased from 22% to 32% over the course of Year 3. The mean number of different activities in which each skill was observed increased from 2.4 to 3.5. These data provided evidence of increasing integration of functional object interaction skills across the typical preschool day.

Table 5. Percent of activities in which each object interaction skill was observed in model classroom in Year 3

Object Interaction Skills	Fall	Spring
WAYS TO GAIN ACCESS TO OBJECTS		
Make Detour	73%	64%
Remove Barrier	27%	27%
Over/under barrier	45%	27%
Locate	36%	36%
Simple search	9%	27%
Complex search	0%	27%
Take out	54%	45%
Open simple container	18%	54%
Open complex container	9%	36%
Simple tool to gain access	0%	18%
Complex tool to gain access	0%	9%
WAYS TO USE OBJECTS		
Functional use	45%	45%
Orient	27%	45%
Put in	54%	54%
Activate simple object	27%	45%
Operate complex object	0%	0%
Adjust plane	36%	45%
Simple action on another object	36%	64%
Complex action on another object	0%	27%
Rotate shapes	9%	18%
Match shapes	9%	9%
Construct/assemble simple	9%	27%
Construct/assemble complex	0%	9%
Use container	9%	0%
Mean % of activities in which skills observed	22%	32%
Mean # of activities in which any skill observed	2.4	3.5

The newly developed environmental inventory (now titled *Design to Learn*) was also administered on a pre-intervention basis to target activities of students in our model demonstration classroom in Year 3 and once again in the Spring (n = 6). The results of this administration appear in Table 6. The data show that the two sections most related to project intervention, “Opportunities to Use Objects” and “Materials”, showed improvement across students.

Table 6. Mean *Design to Learn* scores across Year 3 participants

Section	Mean Score: Fall	Mean Score: Spring
Transition	9%	11%
Activity	100%	100%
Communication System	53%	71%
Adult Interaction	90%	93%
Group Dynamics*	0%	0%
Opportunities to Communicate	27%	43%
Opportunities for Object Use	39%	53%
Materials	57%	79%

* This section is not applicable to the 1:1 specific skill instruction activities on which *Design to Learn* was administered.

IV. Activities for Years 4 and 5

Years 4-5 involved replication activities. In the original model classrooms, teaching responsibilities shifted from project staff to classroom staff. Project goals now included an emphasis on examination of the new skills included in the Social Use strand of the revised assessment instruments. There was also an emphasis on expanding the classroom's ability to design and deliver meaningful instruction. Classroom staff began to develop their own data collection strategies and use data to influence their decisions about instruction.

A. Model Implementation in Replication Sites

The replication activities also involved two new classrooms. Replication activities thus involved three major efforts: providing technical assistance to the original model demonstration classroom; replicating the model in two additional sites (one in each of Years 4 and 5); and conducting validation studies of the new assessment instruments.

<u>Continuing technical assistance and evaluation to original site</u>

Project staff maintained the office provided to the project at the preschool site and provided technical assistance and consultation to the original model demonstration classroom there. Project staff trained a teaching assistant from the model classroom in Year 4 and monitored that person's delivery of project related activities. Project staff also conducted evaluation activities to document the continued progress of students in that classroom. The teacher from the model classroom also participated in regular meetings held with the replication site staff.

<u>Providing staff and parent training in replication sites</u>

In Year 4, replication sites were selected by early October. After consents were gathered from both the participating educational personnel and parents, an initial training meeting was held in late October. Parents, teachers and other educational personnel involved in the project attended this meeting, which covered the following topics:

Training 1.
- Overview of the Project
- Data to date
- Parent/Teacher Collaboration
  - Assessment
  - Learning Plan

Two additional trainings with the participants followed. Brief outlines of those meetings are presented below.

Training 2.
- Develop Learning Plan
- Video Analyses of Instruction with Target Children
- Teaching and Learning
  - Intervention Strategies

Training 3.
- Teaching and Learning (continued)
- Environmental Engineering
- Monitoring Performance
  - Data Collection Strategies

Visits were arranged for the staff from the replication sites to observe in the model classroom. Arrangements made with the school program provided grant funds for teacher substitutes to enable teachers to accomplish this activity. Project staff provided three additional trainings targeting educational assistants in the replication classroom. In support of that training, staff developed a Materials Checklist (Figure 4) to be used by classroom staff to inventory everyday materials found in their classroom. This list is cross-referenced to the skills found in the Hands-On Learning assessments. Completion of this checklist by the staff proved to be a very useful way of introducing them to the cognitive skills targeted by the project and the naturally occurring opportunities for learning in their classroom.

Materials Checklist

Materials		
	I. Obtaining Objects	A. Goes Over/Under Barriers
	I. Obtaining Objects	B. Removes Barriers
	I. Obtaining Objects	C. Makes Detours
	I. Obtaining Objects	D. Locates Objects
	I. Obtaining Objects	E. Simple Search
	I. Obtaining Objects	F. Complex Search
	I. Obtaining Objects	G. Takes Out/Puts In
	I. Obtaining Objects	H. Opens Simple Containers
	I. Obtaining Objects	I. Opens Complex Containers
	I. Obtaining Objects	J. Uses Containers to Carry
	I. Obtaining Objects	K. Uses Simple Tools to Gain Access
	I. Obtaining Objects	L. Selects and Uses Tools to Gain Access
	II. Practical Uses	A. Simple Actions on Objects
	II. Practical Uses	B. Explores Objects
	II. Practical Uses	C. Functional Uses
	II. Practical Uses	D. Transfers Objects
	II. Practical Uses	E. Adjusts Surface
	II. Practical Uses	F. Simple Combinations
	II. Practical Uses	G. Complex Combinations
	II. Practical Uses	H. Turns On/Off
	II. Practical Uses	I. Operates Complex Objects
	II. Practical Uses	J. Puts Together
	II. Practical Uses	K. Uses Tool to Assemble/Disassemble
	II. Practical Uses	L. Constructs
	III. Representational Uses	A. Pretend Play toward Self
	III. Representational Uses	B. Pretend Play toward Objects
	III. Representational Uses	C. Pretends to Be Something Else Using Objects as Props
	III. Representational Uses	D. Matches by Manipulation
	III. Representational Uses	E. Matches to Simple Visual Features
	III. Representational Uses	F. Matches to Complex Visual Features
	III. Representational Uses	G. Uses 2-Dimensional Information
	III. Representational Uses	H. Uses Abstract Information
	IV. Social Uses	A. Uses Objects Alone in Social Contexts
	IV. Social Uses	B. Simple Reciprocal Activity
	IV. Social Uses	C. Takes Turns
	IV. Social Uses	D. Helps in Repetitive Activity
	IV. Social Uses	E. Cooperative Interaction
	IV. Social Uses	F. Plays Game with Peer
	IV. Social Uses	G. Plays Game in Group

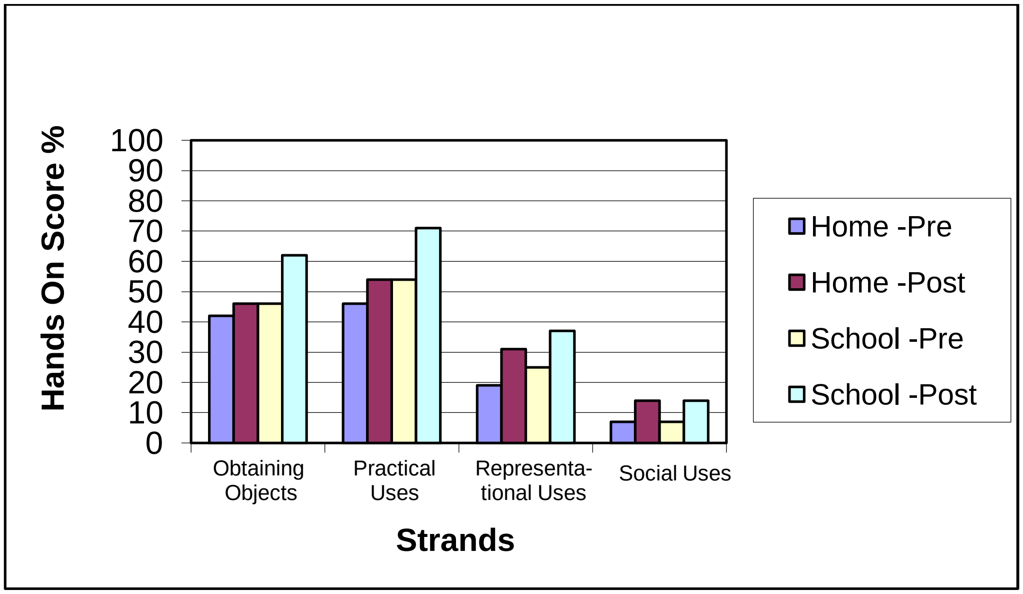
Figure 4. Materials Checklist

In Year 5, replication and model classroom teachers met together with project staff. Standing invitations were put out for any other classroom and support staff interested in participating in these ½ day sessions. The twice-monthly meetings replaced project participation in the weekly classroom staffings. This meeting time combined training with time to discuss each child individually.

Conducting assessments in replication sites

The classroom teacher conducted assessments in collaboration with project staff. This support generally took the form of a meeting to discuss the assessment results and any issues on which the teachers sought clarification. If they were uncertain about whether a child possessed a particular skill, project staff were available to conduct observations of the student in the classroom and to discuss possible strategies for testing that skill. A parent assessment packet including *Hands-On Learning at Home* was sent home to the families of project participants in the replication sites. In one instance, a parent for whom English was his second language met with project staff to complete these assessments. Project staff members were also available by phone to field any questions as they arose. Across Years 4 and 5, parents completed 61% (17/28) of the assessments requested. Figure 5 shows pre-post *Hands-on Learning* scores from school and home for one participant. Assessment results are discussed in Section VI of this report.

Figure 5. Sample *Hands-On Learning* scores from school and home



<u>Developing learning plans for students in replication sites</u>

Learning plans were developed independently by replication site staff, and then reviewed in a collaborative effort with project staff. Learning plans provided for the side-by-side comparison of home and school assessment results. (the Learning Plan is attached in Figure 6). From this perspective, parents and teachers could discuss any discrepancies between the two environments and select skills to be targeted at school and, if requested, at home. In Year 4, three students had such follow-up in the home from classroom staff. Across Years 4-5, a variety of skills were targeted. Noteworthy was the distinctly individual nature of the skills selected for each learner. Teachers and parents selected skills from a variety of skill clusters across the four strands. For all but one student, parent and teacher chose to target one or more skills in the Social Uses strand. By Year 5, 46% of all the skills targeted were from that strand. The skills selected in many instances followed a progression of skill complexity: for example Put Together might be targeted first and when that was mastered, then Construct would be targeted. The average number of skills targeted for each learner across Years 4 and 5 was six.

Object Interaction Skills			Assessments*			Instructional Plan	
	Cluster	Skill	[illegible]	[illegible]	[illegible]	Instruction*, Context, Materials	Follow Up
I. OBTAINING OBJECTS	Negotiating Barriers	A. Goes Over/Under Barriers					
		B. Removes Barriers					
		C. Makes Detours					
	Searching & Locating	D. Locates Objects					
		E. Simple Search					
		F. Complex Search					
	Using Containers	G. Takes Out/Puts In					
		H. Opens Simple Containers					
		I. Opens Complex Containers					
		J. Uses Containers to Carry					
	Using Tools to Gain Access	K. Uses Simple Tools to Gain Access					
		L. Selects & Uses Tools to Gain Access					
II. PRACTICAL USES	Basic Object Use	A. Simple Actions on Objects					
		B. Explores Objects					
		C. Functional Uses					
	Combining Objects	D. Transfers Objects					
		E. Adjusts Surface					
		F. Simple Combinations					
		G. Complex Combinations					
	Activating Objects	H. Turns On/Off					
		I. Operates Complex Objects					
	Constructing Objects	J. Puts Together					
		K. Uses Tools to Assemble/Disassemble					
		L. Constructs					
III. REPRESENTATIONAL USES	Pretending	A. Pretend Play toward Self					
		B. Pretend Play toward Objects					
		C. Pretends to Be Something Else Using Objects or Props					
	Understanding Associations	D. Matches by Manipulation					
		E. Matches to Simple Visual Features					
		F. Matches to Complex Visual Features					
	Using Representational Information	G. Uses 2-Dimensional Information					
		H. Uses Abstract Information					
IV. SOCIAL USES	Simple Interactions	A. Uses Objects Alone in Social Contexts					
		B. Simple Reciprocal Activity					
		C. Takes Turns					
	Cooperating	D. Helps in Repetitive Activity					
		E. Cooperative Interaction					
	Playing Games	F. Plays Game with Peer					
		G. Plays Games in Group					

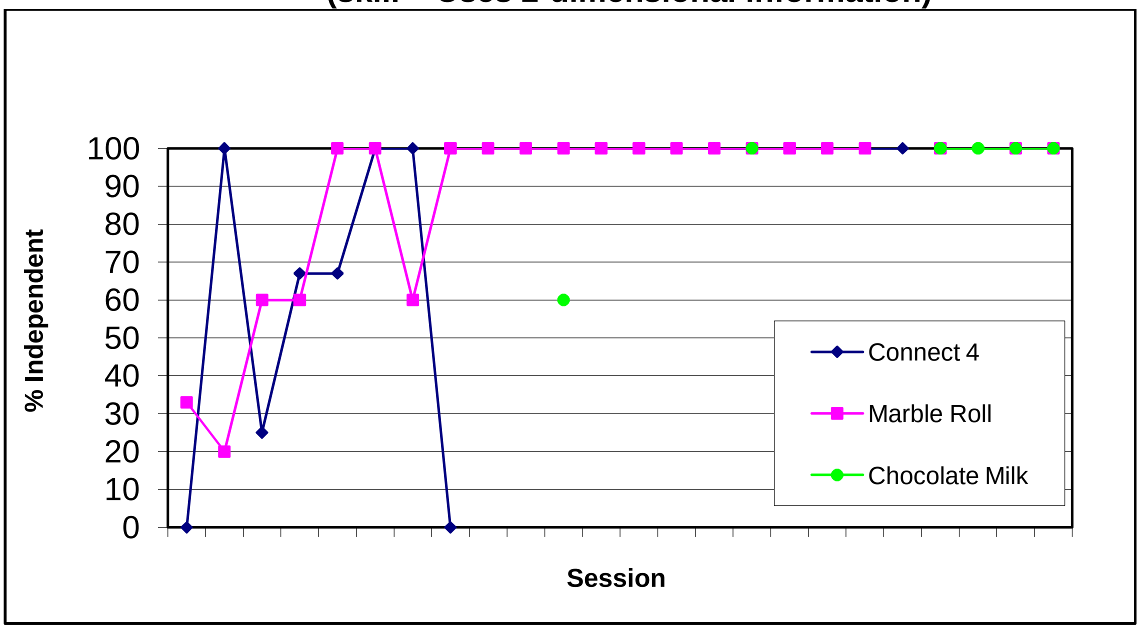
*Mastered skill = X Emerging skill = /
*Specific skill instruction = SI Environmental engineering = EE

learning plan

Figure 6. Learning Plan

The learning plan also tracks the intervention strategies employed, tying that decision directly to the assessment information described in the plan. For example, skills that did not show up in either the home or school environments but that were considered important for the child at this time might require specific skill instruction. In the instance where the child exhibits the skill in one environment but has not generalized its use to other settings, specific skill instruction of the emerging skill across new contexts and materials might also be appropriate. For some learners, it might only be necessary to engineer the environment to insure that opportunities exist for him to practice and apply the skill in that environment without directly teaching it. A review of the learning plans across Years 4-5 suggests that instruction usually took the form of specific skill instruction, often involving a general case strategy initially (see discussion of instructional strategies in the Teacher's Guide.) In such a strategy generalization is built into the instruction through the use of multiple exemplars. Figure 7 provides an example of such data.

Figure 7. Sample data from program using multiple exemplars (skill = Uses 2-dimensional information)



The instructional strategies employed depend on what is most effective for the individual child: strategies will change as the learner moves towards mastery. That transition, as well as a shift in targeted skills, is illustrated on the learning plan. Across

Years 4-5, the educational teams chose to target 30 new skills initially scored as "Not Present" and 40 skills that were initially scored as "Emerging".

Providing teaching and learning experiences

In the Year 4 replication classroom project staff involvement ranged from specific skill instruction, to coaching of classroom personnel as they delivered instruction, to monitoring classroom instruction through data collection. In every case, the goal was to release these duties to classroom staff as soon as appropriate. Across both the model and replication classrooms in Year 4, project staff provided specific skill instruction for 54% of the skills targeted. In Year 5, project staff did not conduct any specific skill instruction in either the replication or model classrooms, but continued to provide the other supports described above. In addition, project staff maintained a collection of instructional materials that were offered to the classrooms. This collection provided a ready supply of age appropriate, motivating and challenging objects to maintain the learners' interests.

Intervention records were used to adjust the various instructional strategies being used to teach object interaction skills to each child and in response to the child's performance. The Object Interaction Intervention Record (Figure 8) is divided into three sections, each focusing on a different aspect of instruction. **Assessment and Monitoring for Progress** covers initial evaluation of the learners' skills and preferences, as well as ongoing monitoring of their development, and changes in the learning situation. **Teaching Routines** addresses the specifics of how teaching opportunities are provided, focusing on the aspects of cues, responses and consequences of the instruction. The **Environment** treats the changing aspects of the environment that the learner must contend with as she moves toward mastery of targeted object interaction skills. A glossary defining the terms used in this form is provided in Figure 9. Beyond the specific skill instruction of targeted object interaction skills, the project concerned itself with encouraging the integration of these learning opportunities across the entire school day. At the suggestion of the teachers in Year 4, posters (as described in Section II) were developed for the various contexts that tend to make up typical early childhood school environments. The posters list each of the

Hands-On skills and provide space to indicate the children for whom the teacher may want to target specific skills and the materials to use. The posters serve as visual reminders to the staff working in that context any time the specific child is present. In this way, learning opportunities may be expanded beyond specific skill instruction times to the entire school day.

Object Interaction Intervention Record

Student ________	Date			Date			Date		
Targeted Skill									

Assessment and Monitoring for Progress

Assessment: School									
Home									
Preference Probes									
Environmental Inventory									
Materials Checklist									
Target Skill: Acquisition									
Generalization									
Skill Tracking									

Teaching Routine (cues, responses and consequences)

Materials									
Presentation									
Instructional Cues									
Response									
Level of Assistance									
Time/Latency									
Consequences if correct response									
if incorrect									

Environment

Setting/Activity									
Partner									
Position									
Peer									
Adaptations									

Figure 8. Object Interaction Intervention Record

Figure 9. Object Interaction Intervention Record Glossary

Assessment and Monitoring for Progress

- **Assessment: School and Home.** Indicate if you are conducting a cognitive/object interaction assessment in the home and or school environment.
- **Preference Probes**. Indicate if you are investigating what is motivating to the learner at this time. Often times this is and ongoing part of instruction.
- **Environmental Inventory.** Indicate if you are conducting an analysis of the child's environment to determine existing and new supports to learning.
- **Materials Checklist.** Indicate if you are conducting an inventory of the materials available in your classroom to determine those best suited to teach specific skills.
- **Target Skill:** Acquisition and Generalization. Indicate if the object interaction skills you are targeting are for initial learning or generalization of the skill.
- **Skill Tracking:** Indicate data collection strategy (e.g. trial-by-trial; probes) and the schedule (e.g. daily; Thursday at snack)

Teaching Routine: (cues, responses and consequences)

- **Materials.** List the specific objects that are being used to teach or practice the target skills.
- **Presentation.** Describe the manner in which objects are presented to the learner (e.g. to his left, randomly, with contrasting backgrounds etc.).
- **Instructional Cues.** Describe what the teacher does to elicit a response from the learner.
- **Response.** Describe how the learner is to respond (Note: in some instances as in mastered with limitations, the targeted response may be different than independent action on the object).
- **Level of Assistance.** Describe any physical assistance, model/demonstration, or other assistance that is being provided to the learner to make his response.
- **Time/Latency.** Indicate the amount of time to be allowed the learner to respond.
- **Consequence.** Describe the manner in which the partner responds when the learner makes a correct and an incorrect response.

Environment

- **Setting/Activity**. Describe the context in which the learning opportunity is being targeted.
- **Partner.** List the person(s) with whom the learner will be interacting in the target activity.
- **Position.** Describe any unique positioning considerations that will be made to enable the learner to respond.
- **Peer.** List the peer(s) with whom the learner will be interacting in the target activity.
- **Adaptations.** List any other (in addition to those described under presentation or position) modifications that are made to the activity, materials ,etc. to better allow the learner to respond.

Monitoring student performance

In Year 4, project staff met weekly with the teachers of the model and replication classrooms to discuss each participant's performance. Project staff provided support needed to promote continued child progress. Teachers were encouraged to design their own forms as well. In addition, project staff met weekly with the educational assistant of the model classroom to review data and data collection techniques and to discuss instructional strategies. In Year 5, meetings with the educational teams continued to include review of data collected and observations of videotapes made of the child engaged in targeted activities.

Classroom and project staff also used *Design to Learn* to monitor the learning environment. As described earlier, this tool is intended to focus the attention of the observer on the learning opportunities that are or are not being provided for a specific child in a specific activity: it does not address the child's skill. As a result of such an environmental analysis, the teacher may modify the activity to increase or change the nature of learning opportunities. These data are described in section VI.

Collecting data to validate new assessment instruments and provide comparison data

Dr. Robert Stillman, project consultant, collected data on children with PDD enrolled in classrooms at the Callier Center for Communication Disorders at the University of Texas in Austin. Those data provided additional validation of the assessment instruments and also provided data on a small group of young children with PDD who did not receive intervention through our project. These data are reported in Section V.

V. Effectiveness of Instruments Developed through the Project

Two instruments were developed to assess the child's object interaction skills (a home and a school version). In addition, an environmental inventory was developed to measure the degree to which the teaching environment supports learning of skills by specific children in specific activities. These instruments were adaptations of instruments developed through earlier research efforts for different populations. Significant efforts in the final two years of the project were devoted to analyzing the properties of these new instruments.

A. Child Skill Assessments: *Hands-on Learning at School* and *at Home*

The final instruments have been described in Section II. A field test was conducted to collect data describing the target population using these instruments and to compare the scores of children with PDD with those of age mates without disabilities. The results provide a comparison of parent and teacher perspectives on child development; descriptive data from a sample of this low-incidence population; and data related to the validity of the instruments.

1. Method

Children with PDD between the ages of 2 and 6 years were recruited through contacts with local public schools. In addition, Dr. Robert Stillman provided access to children with PDD who attended the Callier Center for Communication Disorders in Dallas, TX. Parents were asked to complete the home assessment and to permit their children's teachers to complete the school assessment. Parents and teachers were offered an incentive payment of $15.00 for completing each assessment. Along with the assessments they were given forms on which to evaluate the instruments and they were requested to complete basic demographic information (age, ethnic background, means of communication) on their children. In some cases the assessments were completed twice –in the fall and spring of the same school year. We received at total of 85 assessments, on 41 different children with PDD. The 41 different children ranged in age from 25 to 70 months, with a mean age of 46 months. Nineteen were male, 5 were female and gender was not available for the remaining 17. 22% listed ethnic background as Caucasian, 7% as African American, 5% Hispanic/Latino, 5% Other and the remaining 61% did not provide this information. Of the initial round of assessments ("pre-tests"), we received parent and teacher assessments on 32 children, with unmatched parent assessments on 2 children and unmatched teachers assessments on 7 children. Among the second set of assessments ("post-tests") that we received on some of these subjects were 4 matched parent/teacher assessments, 7 unmatched parent assessments and 1 unmatched teacher assessment.

Children without disabilities between the ages of 3 and 5 years were recruited from the same local classrooms which included children with PDD. In addition, some 1-2 year old children were recruited through two local private preschool programs and personal contacts with individual families. Parents were offered an incentive payment of $15.00 for completing each assessment and were requested to complete basic demographic information (age, ethnic background, means of communication) on their children. We received parent assessments on 48 different children without disabilities. These children ranged in age from 12 to 66 months, with a mean age of 39 months. 22 were male and 26 were female. 65% listed ethnic background as Caucasian, 7% as African American, 6% Hispanic/Latino, 27% Other and 1 family (2%) did not provide this information.

2. Results

Comparison of parent scores to teacher scores. We received 36 paired assessments of children with PDD, of which 32 were initial assessments: these "pre-tests" were used for this analysis. It was anticipated that parents and teachers might perceive children differently because of their different levels of experience with the particular child (parents having more experience) or with children who have disabilities (teachers generally having more experience). However, it was assumed that differences between teacher and parent scores would not be great. This hypothesis was supported. The mean total score on the parent assessments was 60% and on the teacher assessments was 55%. A repeated measures ANOVA conducted on the Total Score by the within-subjects factor of Respondent (Parent versus Teacher) yielded a nonsignificant $F=3.054$. Strand scores for parents versus teachers were 73% versus 66% for Strand I; 70% versus 64% for Strand II; 48% versus 43% for Strand III; and

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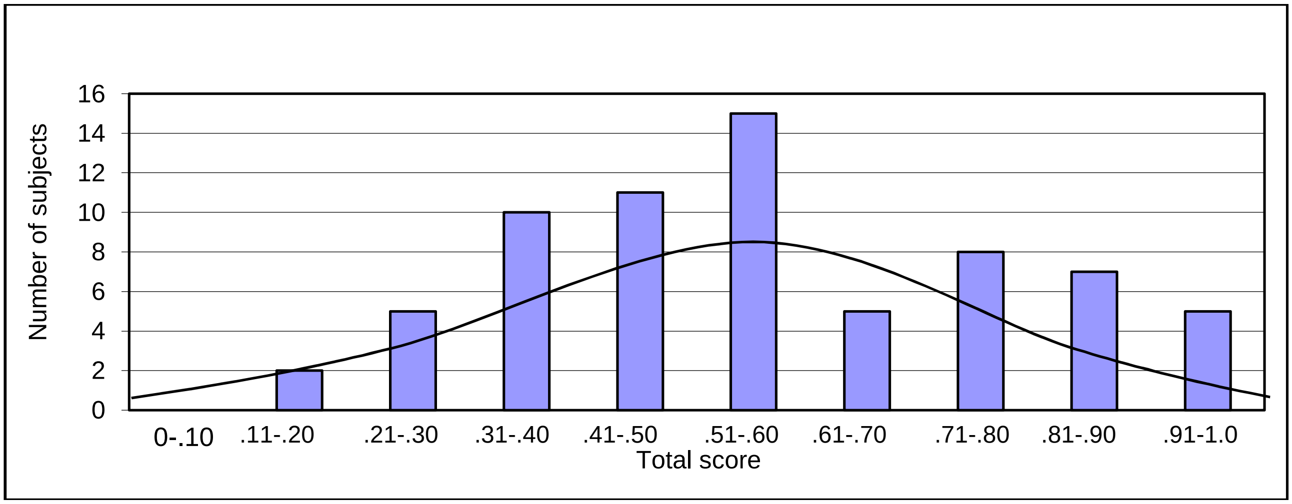
35% versus 32%for Strand IV. A repeated measures ANOVA with within factors of Respondent (Parent versus Teacher) and Strand (I-IV) showed a significant effect of Strand ($p < .000$), no effect of Respondent, and no interaction between the two factors.

Inter-observer reliability between teachers and parents was analyzed for each parent/teacher pair and for each item. For these analyses, we combined scores of “Emerging” and “Mastered”, so that an agreement was scored if both parents and teachers scored the item as either “Emerging” or “Mastered” or if they both scored it “Not Present”. All 36 paired assessments (“pretests” and “posttests”) were used for this analysis. The mean percent agreement between parents and teachers (# item agreements/# item agreements + disagreements) was 79% (a mean of 31 agreements per parent/teacher pair out of a possible 39), with a range of 62% to 100%, a fairly high level of agreement. The paired assessments were also examined to determine which particular items were subject to the most disagreements between parents and teachers. The mean percent agreement per item was 81% (a mean of 29 agreements per item out of a possible 36), with a range of 56% to 100%.

Adequacy of the assessments for describing the target population. All “pretests” were examined to determine the spread of scores among the subjects with PDD. Scores ranged from 29% to 96% for parents and from 14% to 100% for teachers. The median score was 55% for parents and 51% for teachers. No parent or teacher gave a child a score of 0%, suggesting that the instruments include some items that are applicable to any child with PDD within the sampled age range. Only 1 out of the 68 assessments showed a Total score of 100%, suggesting that it is unlikely that a child of the sampled population with PDD will “test out” of these assessments. Scores were fairly evenly distributed between those points. Figure 10 is a histogram showing the frequency of scores for all teacher and parent “pre-tests” with a normal curve superimposed on the data. Pearson’s product-moment correlations between age and Total score and the four Strand scores were all positive and highly significant ($p<.00$).

Figure10. Distribution of total scores for all "pre-tests" on children with PDD



Comparison data from children without disabilities. Figure 11 compares the Total Score for children without disabilities (Home version only), and for children with PDD (Home versus School versions), with mean scores for subjects grouped by age into 1-year increments. All "pre-tests", matched and unmatched were used. Clearly, the nondisabled children scored higher than their age-mates with PDD at all age levels. Pearson's product-moment correlations between age and Total score and the four Strand scores were all positive and highly significant ($p<.00$) for the children without disabilities.

Figure 11. Total score by age group for three data sets

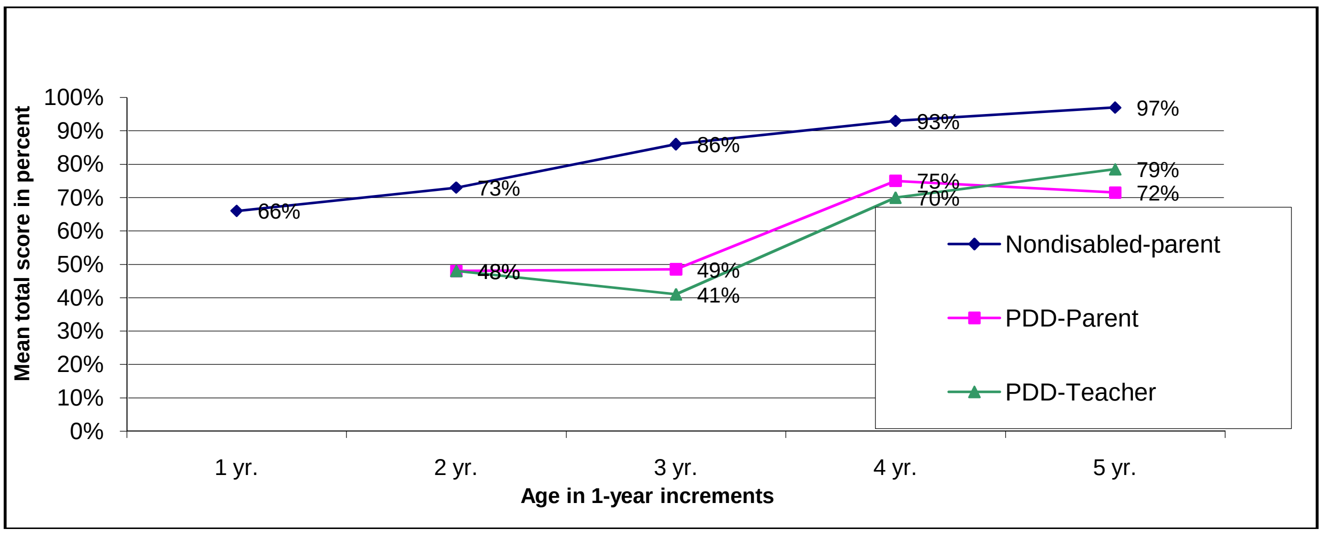
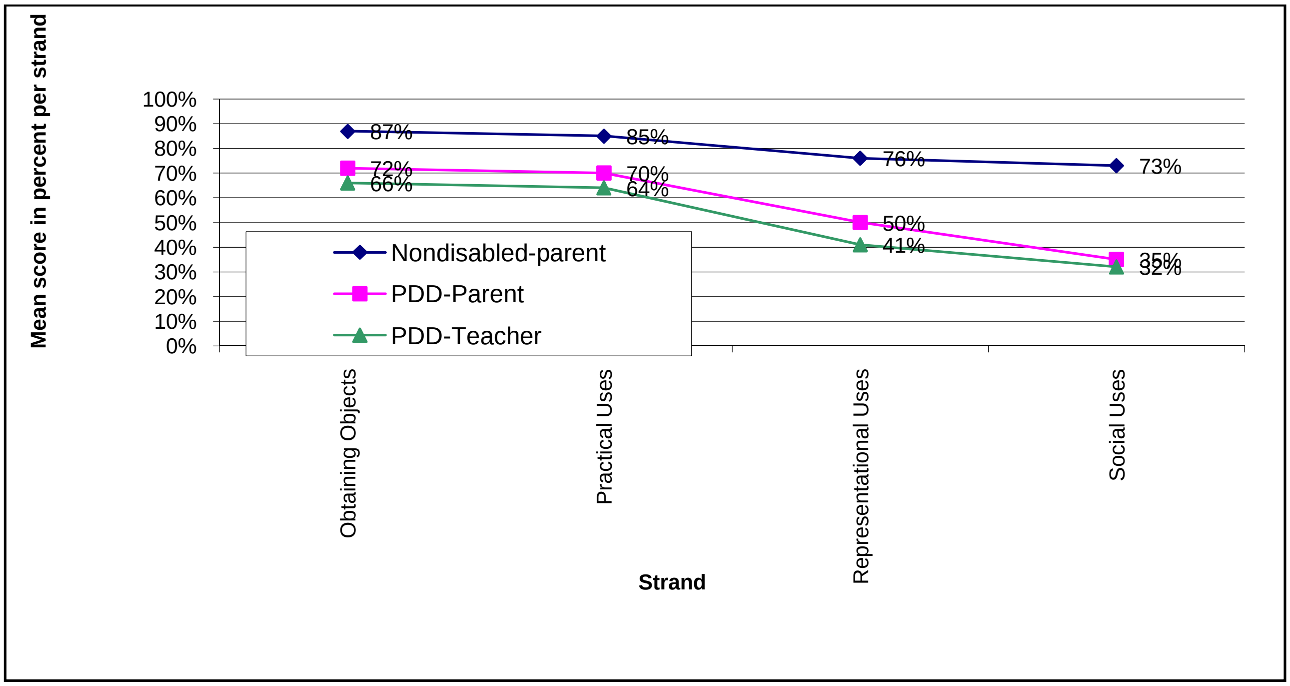


Figure 12 shows mean Strand scores averaged across each of the three sets of data. This figure shows that scores for children with PDD were lower than those of their nondisabled age mates for each strand. Greater disparities are evident for Strands III and IV.

Pearson's product-moment correlations between Strand 4 (Social Uses) and the other three strands were positive and highly significant (p<.00) for all three data sets. Thus, strong object interaction skills that are used for non-social purposes are associated with strong object interaction skills used for social purposes for children with PDD and for their nondisabled peers.

FIgure 12. Strand scores by age group for three data sets



<u>Clusters and Items.</u> Items within each Strand were "clustered" into groups representing related skills. Within each cluster, items were ordered from least to most difficult based on the data from the field test. The following figures show in more detail how the instruments are organized and how the three sets of data compared relative to specific items and to the clusters of items within each strand. Figures 13 through 16 show for each of the four Strands the percent of each set of subjects for whom each item was scored "Not Present". In these figures the higher the percentage the more

difficult the item would be. These figures show increased disparity between children with PDD and age peers for the more difficult items within each cluster.

Figure 13. Percent of subjects without skills: Strand I-Obtaining Objects

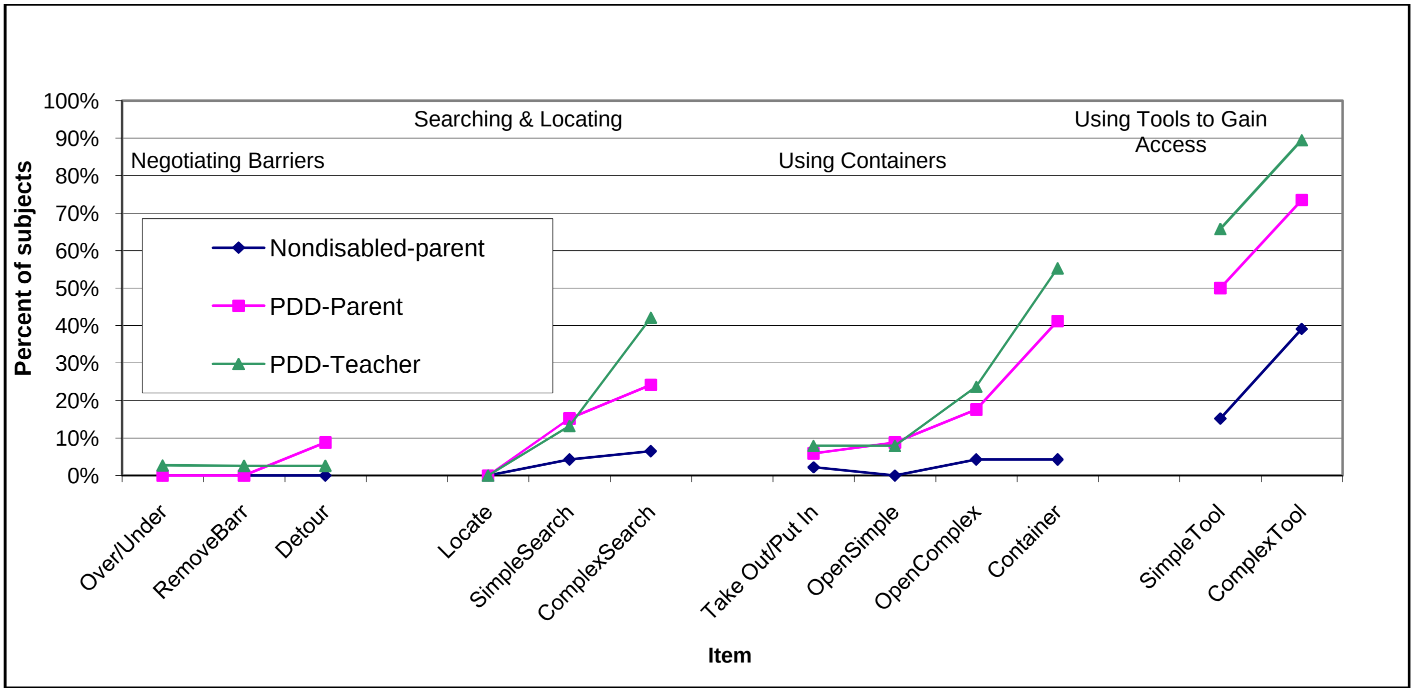


Figure 14. Percent of subjects without skills: Strand II-Practical Uses

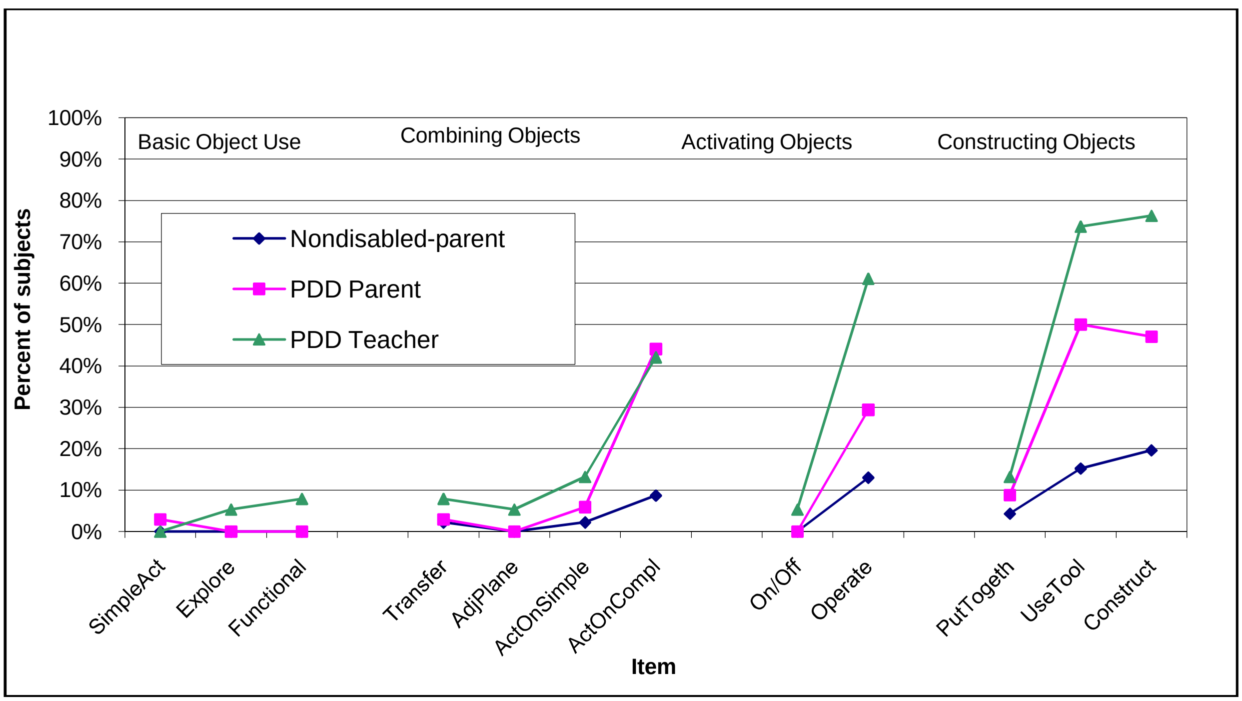


Figure 15. Percent of subjects without skills: Strand III-Representational Uses

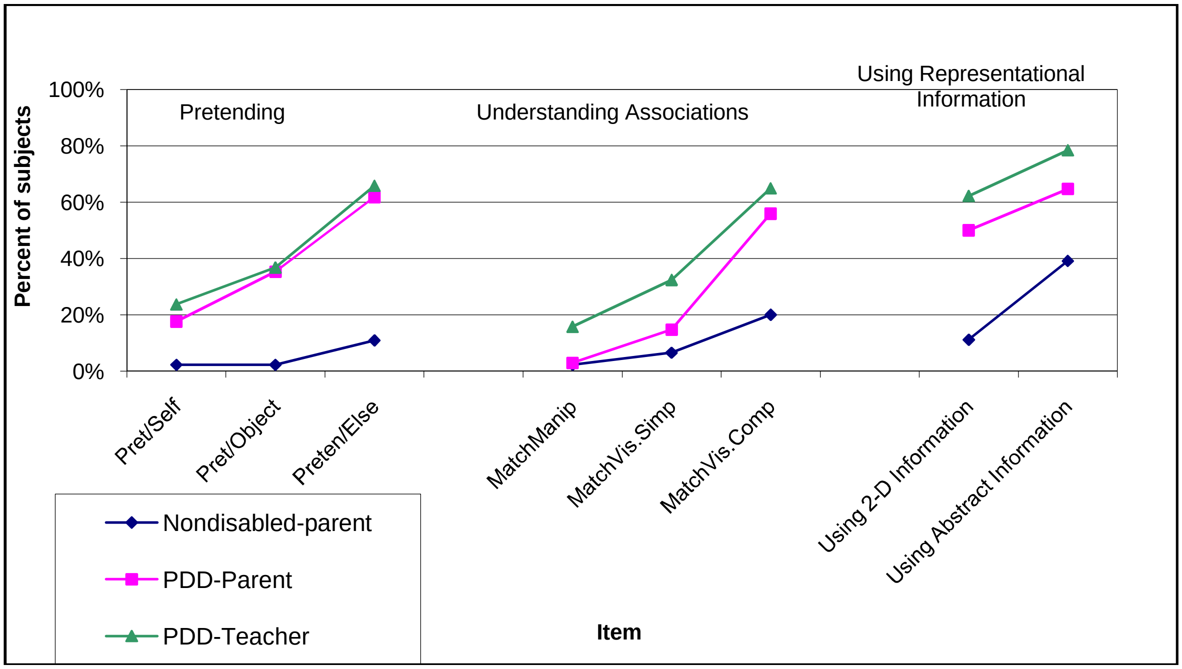


Figure 16. Percent of subjects without skills: Strand IV-Social Uses

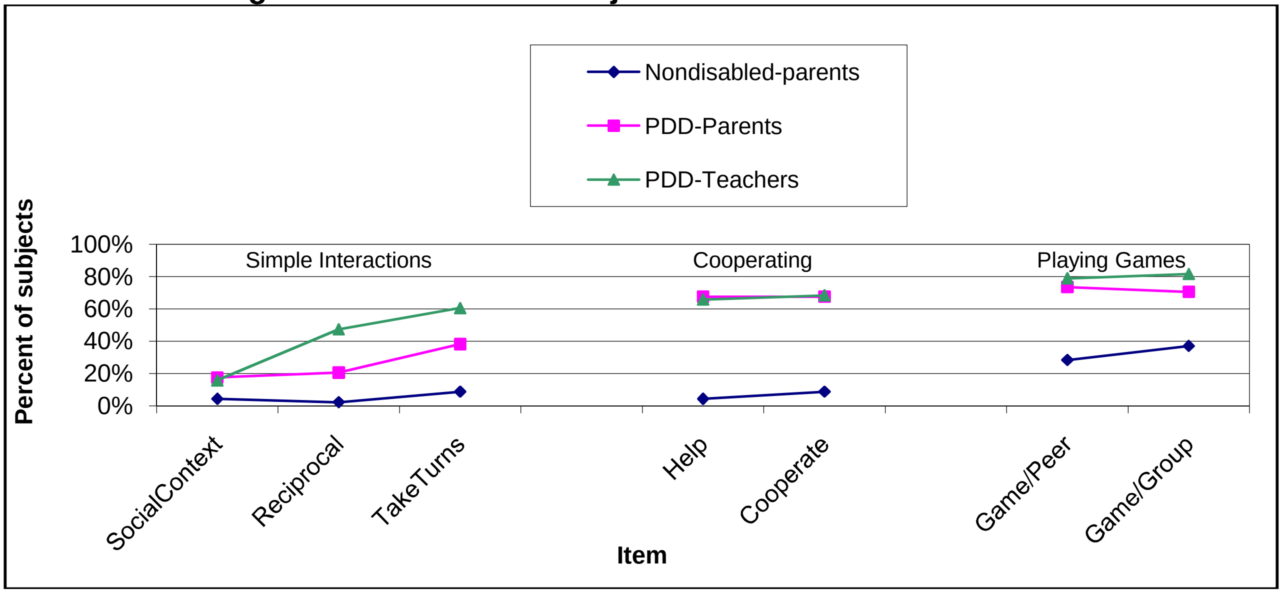
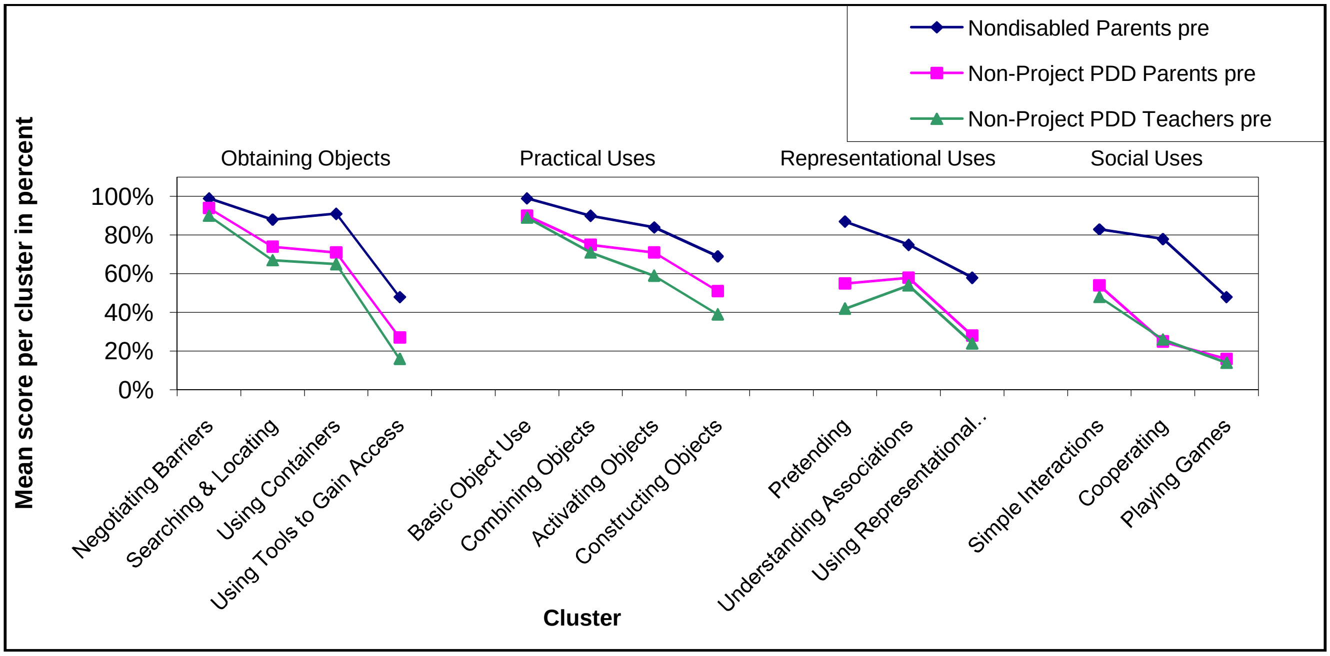


Figure 17 shows scores by cluster across each of the four Strands for the three sets of scores. This figure demonstrates the overall ordering of clusters and strands from least to most difficult.

Figure 17. Mean cluster scores for three data sets

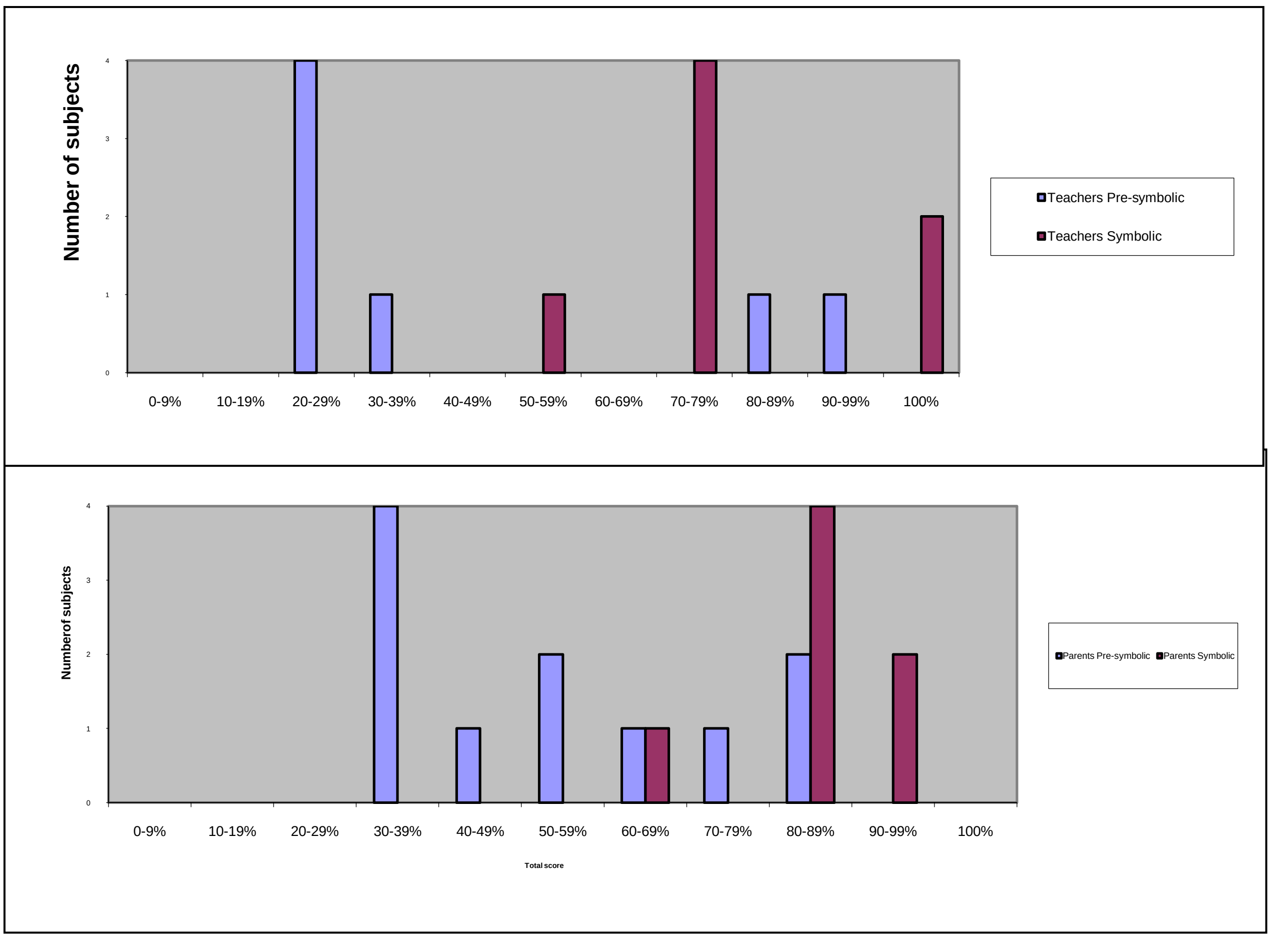


Item analysis. The data were examined to determine how many of the field-test subjects with PDD received scores of either Mastered or Emerging for each item, in order to evaluate the suitability of specific items for the target population. Each skill was demonstrated by at least 11% of subjects and only one skill (Locate) was demonstrated by all subjects according to both parents and teachers. The items therefore appeared to be appropriate for the population of children with PDD.

Relationship of *Hands-On Learning* scores to child's communication skill. The *Hands-On Learning* assessment instruments had been developed specifically with the needs of the nonspeaking child in mind. The instruments from which they were adapted had proven to be only marginally useful for children who used some sort of symbolic communication, since most of these children scored between 90-100% (Rowland & Schweigert, 2001). One of the questions asked on the demographics form provided to parents in this study provided a rough level of the child's communicative ability, including whether the child used any sort of symbols to communicate. Figure 18 shows total scores from the parent versus teacher "pre-tests" for children with PDD, distinguishing between those who used some sort of symbolic system to communicate and those who communicated strictly through pre-symbolic means. The range for the

Total score for children who communicated pre-symbolically was .21-.91 as compared to .58-1.00 for children who used symbols to communicate. Although the symbolic communicators performed better, their scores were distributed fairly evenly across the upper two quartiles of the score distribution. ANOVAs were run separately for the parent pre-tests and the teacher pre-tests on Total score and the four Strand scores with the between-subjects dichotomous variable of Symbolic Communication. Results revealed significant differences between the two groups on all measures (p<.00) for parent and teacher scores. Person's product-moment correlations were also run between Strand IV (Social Uses) and the other three strands for the two data sets. These correlations were equally strong for pre-symbolic and symbolic children (p<.00).

Figure 18. Total score distribution for symbolic versus pre-symbolic children with PDD



Ratings of the assessments by parents and teachers.

Parents rated the home version using a form with four questions to be answered using a 5-point Likert scale, with 1 = Strongly Disagree and 5 = Strongly Agree. They were also invited to provide open-ended comments. 24 parents responded. Mean responses for the first 4 questions appear in Table 7.

Table 7. Parent evaluation scores for *Hands-On Learning at Home*

Question	Mean Score
1. Hands-on Learning at Home is designed to provide a way to look at a child's everyday interactions with objects and describe what those interactions tell us about how well the child understands • how things work • how basic problems may be solved • how objects may be used in play with other children *Hands-on Learning at Home* serves the purpose described above.	4.1
2. This way of looking at my child's abilities is useful to me.	3.9
3. The kind of information provided by *Hands-on Learning at Home* would be helpful for my child's teacher.	4.1 4.1
4. *Hands-on Learning at Home* is clear and easy to understand.	4.1

Open-ended comments from parents included:

- "Quick and doesn't require a lot of thought"
- "It pointed out clearly what my child can do and what she can't, at this time, and what she needs to work on"
- "Easy to follow and understand"
- "Clear descriptions of behaviors and examples"
- This helps me see how much progress [my child] has made"
- "You ask good questions"
- "I like the fact that I can understand what my child does"
- "Easy to answer questions"
- "It was clear and easy to fill out. I liked the illustrations. They were helpful in a whole understanding of the questions".

Teachers were also provided an evaluation form for the school version with six questions to be answered using a 5-point Likert scale, with 1 = Strongly Disagree and 5 = Strongly Agree. Ten teachers responded. Mean responses for the first 6 questions appear in Table 8.

Table 8. Teacher evaluation scores for *Hands-On Learning at School*

Question	Mean score
Hands-on Learning at School is designed to provide a way to look at a child's everyday interactions with objects and describe what those interactions tell us about the child's cognitive abilities–that is, how well the child understands • how objects work • how basic problems in the physical environment (such as gaining access to desired objects) may be solved • how objects may be used in play with other children *Hands-on Learning at School* serves the purpose described above.	4.3
2. This way of looking at the abilities of a child with PDD is useful to me.	4.1
3. The kind of information provided by *Hands-on Learning at School* would be helpful for establishing intervention priorities.	4.3
4. *Hands-on Learning at School* is clear and easy to understand.	4.3
5. The examples provided for each item are helpful and cover a range of ability levels.	4.5
6. I would use *Hands-on Learning at School* to assess other students with PDD.	4.2

Question 7. asked whether there were other populations for whom the respondent thought the instrument would be useful. Responses included:

- "Lower functioning Down Syndrome"
- "Birth to three children"
- "MR,VI"
- "ECSE"
- "Those children who test low on cognitive but much lower socially".

Open-ended comments from teachers included:

- "Good for everyday instruction strategies"
- "Helps identify gaps in learning and gives suggestions on how to integrate these missing skills into functional classroom activities"
- "Quick and easy—good for higher and lower functioning kids—"teases out" exactly where basic cognitive skill deficits are"
- " Nice tool for object use and interaction with environment"
- "The examples were very clear".

Parents and teachers were also asked for suggestions to improve the assessments. Many of these suggestions were incorporated into the final revisions of the instruments. Revisions included adding new examples for certain items: many of the new examples added were ones that had been written on the assessments by parents or teachers and that seemed particularly common or appropriate. Two items were dropped, and items were re-arranged within clusters based on the percentage of subjects demonstrating each item.

B. Environmental Inventory--*Design to Learn*

Design to Learn (D2L) is designed to help teachers determine to what extent a specific classroom activity encourages skill learning by a specific student. *D2L* is administered to the environment, as opposed to the child, and the resulting scores are independent of child skill level. *D2L* includes 75 items organized into eight sections: Transitions, Activity, Adult's Interaction, Communication System, Peer Interaction, Opportunities to Communicate, Opportunities to Use Objects, and Materials. Together, the eight sections show that both cognitive and communicative development may be targeted in the same activity. This inventory was subjected to a number of analyses of reliability and validity.

Test-retest reliability. 21 graduate students who received training from project staff through a course offered for master's level students at Portland State University were required to administer *D2L* to a student with disabilities in the same activity on two separate occasions, spaced no more than two weeks apart. The number of school days between administrations ranged from 2 to 10 and averaged 4 days. The subjects on whom the inventory was administered ranged in age from 1 to 12 years, with a mean age of 4 years. Subjects demonstrated a wide range of disabilities. The mean agreement (#item agreements/# item agreements + disagreements) between the two administrations was 91%.

Inter-observer reliability. *D2L* was administered by project staff to all videotapes made of student participants in model and replication classrooms. Inter-observer reliability was assessed between two project staff on at least 20% of the videotaped sessions for each participant. Project staff first scored the videotapes independently and then engaged in a consensus process to determine the final score. The mean percent agreement (conducted on 45 videotaped sessions) was 99% across Years 4 and 5.

Correlation with object interaction and communicative behavior. The videotapes of children with PDD in model and replication classrooms were also analyzed using two other observational codes. The Object Interaction code was used to document on a minute-by-minute basis the presence or absence of any of the 39 object interaction skills from the *Hands-On Learning* assessments. The Expressive Communication code was used to document on a 60-second basis the presence of specific types of communication.

To examine the validity of *D2L*, correlations were run between *D2L* scores and summary scores derived from these two observational codes. The purpose was to examine the relationship between *D2L* scores and the actual performance of the child in terms of the frequency of various types of object interaction and communicative behaviors. A strong correlation would suggest that *D2L* scores indeed reflect environmental changes that impact upon child performance. 51 videotaped sessions were involved in these analyses. For the object interaction code, the major measures derived from the coding were:

- P(Initiation): proportion of intervals during which student initiated object interaction
- P(Cues): proportion of intervals during which teachers provided cues for object interaction
- P(Object interaction): proportion of intervals during which student engaged in any sort of object interaction
- # Clusters: number of different clusters (out of 14) represented by the object interaction skills demonstrated by student across the session
- # Complex Skills: number of different complex skills (out of 13) demonstrated by student across the session[1]
- # Different Skills: number of different skills demonstrated by student across the session

Inter-observer agreement computed on a minimum of 20% of the data collected on each student yielded mean agreement of 88% in Year 4 and 91 % in Year 5. Of the six variables described above, all but the first two showed strong Pearsons correlations ($p<.05$) with the total *D2L* score. We would not expect the second measure (cues to

[1] Complex skills were: Complex Search, Opens Complex Containers, Selects and Uses Tools to Gain Access, Operates Complex Objects, Complex Combinations, Constructs, Uses Tool to Assemble/Disassemble, Matches to Complex Visual Features, Uses Abstract Information, Pretends to be Something Else Using Props, Plays Game with Peer, Plays Game with Group, Cooperative Interaction

interact with objects from teachers) to correspond with the *D2L* score because *D2L* tracks more subtle, non-directive sorts of opportunities.

The major variables derived from the Expressive Communication code were:

- P(Communication): proportion of intervals during which student communicated
- P(Cue to Communicate): proportion of intervals during which teacher provided a cue for communication
- P(Peer Cue): proportion of intervals during which peer provided a cue for communication
- # Intents: number of different communicative intents demonstrated by the student
- P(Initiation): proportion of intervals during which student initiated communication

Inter-observer agreement was computed on at least 20% of the data collected on each student. Mean Kappa coefficients (Cohen, 1960, 1969) were 88% for both Years 4 and 5. Of the five variables described above, all but the second (teacher cues) showed strong correlations (Pearsons) with the total *D2L* score ($p<.05$). This may be attributed to the fact that *D2L* is designed to encourage a shift away from teacher cues to more natural opportunities.

Student performance in both object interaction and expressive communication realms was strongly correlated with *D2L* scores. These high correlations support the concept that the instrument measures variables that do indeed affect student performance.

VI. Effectiveness of Intervention Based on Model and Materials:

Results from Years 4 and 5

A. Sites

The replication classroom in Year 4 was run on a supported-integrated model. In Year 5 the replication classroom was self-contained, with reverse integration occurring for part of the day and inclusion into an integrated setting achieved for some students by mid year.

B. Participants

Table 9 shows basic demographics for the ten project participants involved in Years 4/5. All students bore a label of either PDD or autism and were nonspeaking. Three children participated in both Years 4 and 5. These participants were treated as new subjects in Year 5, increasing the “n” to 13 for analyses that span both years.

Table 9. Demographics for Year 4 and 5 participants

Subject	Age	Gender	Ethnicity	Additional Impairments
16b	4.10	M	Caucasian	
17b	4.7	M	Caucasian	
18	3.0	M	Caucasian	
19a,b	3.2	M	Caucasian	
20	4.2	M	Caucasian	
21a,b	2.8	M	Caucasian	
22a,b	3.0	F	Caucasian	
23	4.3	F	SE Asian	
24	3.3	F	African American	Orthopedic impairment
25	4.9	F	Caucasian	

C. Results

Changes in the skill levels of target children and in their classroom environments were assessed on a pre-post intervention basis. *Hands-On Learning at School* and *at Home* were used to assess changes in the child's cognitive skills as demonstrated through interactions with objects at school and at home. *Design to Learn* was used to evaluate changes in the classroom environment that promoted the use of cognitive skills. In addition, skill acquisition data from specific skill instruction activities conducted at school were collected by the instructors. Data on the effectiveness of project interventions are presented below.

1. Cognitive Skills of Participants

Evidence of cognitive skill learning is derived from specific skill instruction data and pre-post testing.

Data from specific skill instruction. Skills targeted for each participant in Years 4/5 appear in Table 10. Examples of the trial-by-trial data from this instruction for Years 4 and 5 participants are presented in Figures 19 to 21. These data show progress toward the acquisition of a variety of different object interaction skills.

Table 10. Skills targeted for year 4-5 participants in direct instruction

Student	Target Skill(s)	
16a	• Plays game in group • Takes turns • Plays game with peer	• Uses simple tool to gain access • Plays game with peer
17b	• Takes turns • Plays game with peer	
19	• Constructs • Uses 2-dimensional information • Simple reciprocal activity	• Takes turns • Uses objects alone in social context
20a	• Puts together • Opens simple container • Simple reciprocal activity	• Opens complex containers • Constructs
20b	• Uses objects alone in social context • Simple reciprocal activity • Takes turns	• Complex combinations • Constructs • Uses simple tools to gain access
21	• Simple search • Complex search • Opens complex containers	• Uses objects alone in social context • Simple reciprocal activity
22a	• Puts together • Constructs • Simple search	• Matches by manipulation • Matches to simple visual features
22b	• Uses 2-dimensional information • Pretend play toward self • Puts together • Constructs	• Complex search • Simple reciprocal activity • Takes turns
23a	• Locates objects • Simple search • Simple combinations	• Uses objects alone in social context • Simple reciprocal activity • Helps in repetitive activity
23b	• Opens complex containers • Simple search • Uses 2-dimensional information	• Takes turns • Puts together
24	• Uses simple tool to gain access • Opens complex containers • Takes turns • Uses 2-dimensional information	• Complex combinations • Uses objects alone in social context • Simple reciprocal activity
25	• Constructs • Takes turns • Opens complex containers	• Uses 2-dimensional information • Complex combinations • Puts together
26	• Uses 2-dimensional information • Constructs • Takes turns	• Operates complex objects • Uses simple tool to gain access • Plays game with peer

a = Year 4
b = Year 5

Figure 19. Participant #21, Year 4, skill= Simple Search

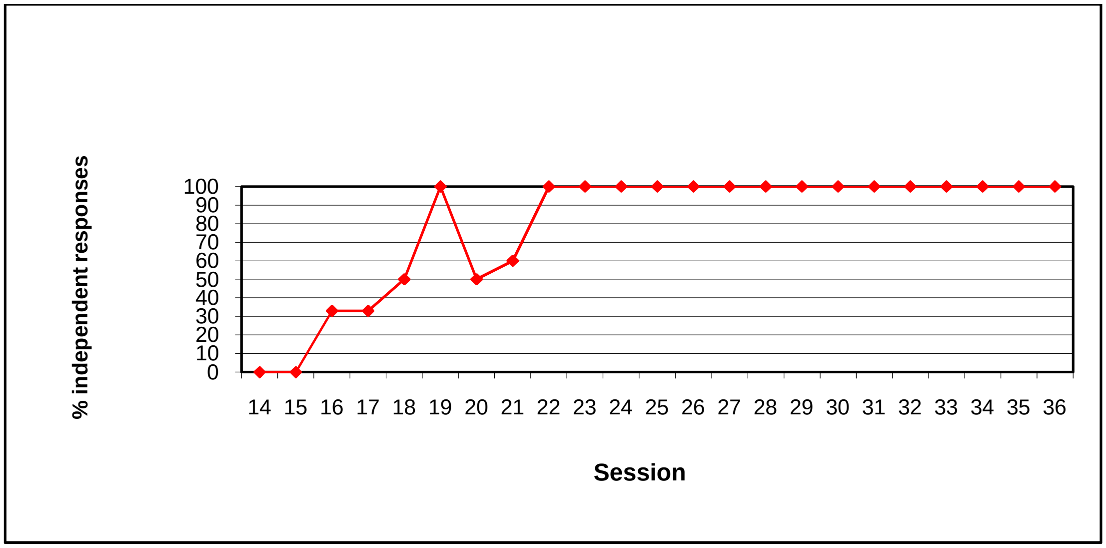


Figure 20. Participant #19, Year 5, skill = Constructs

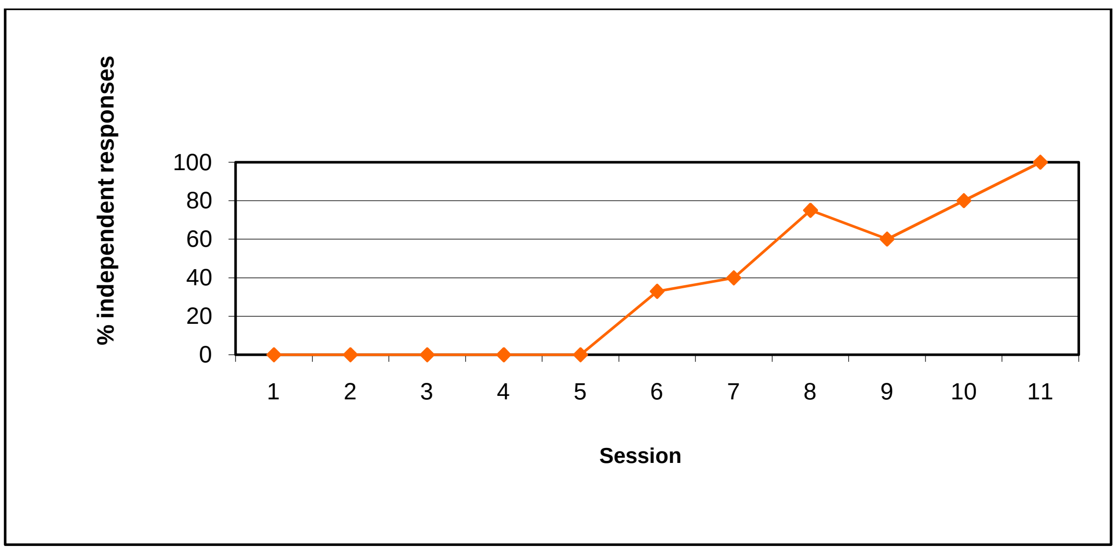
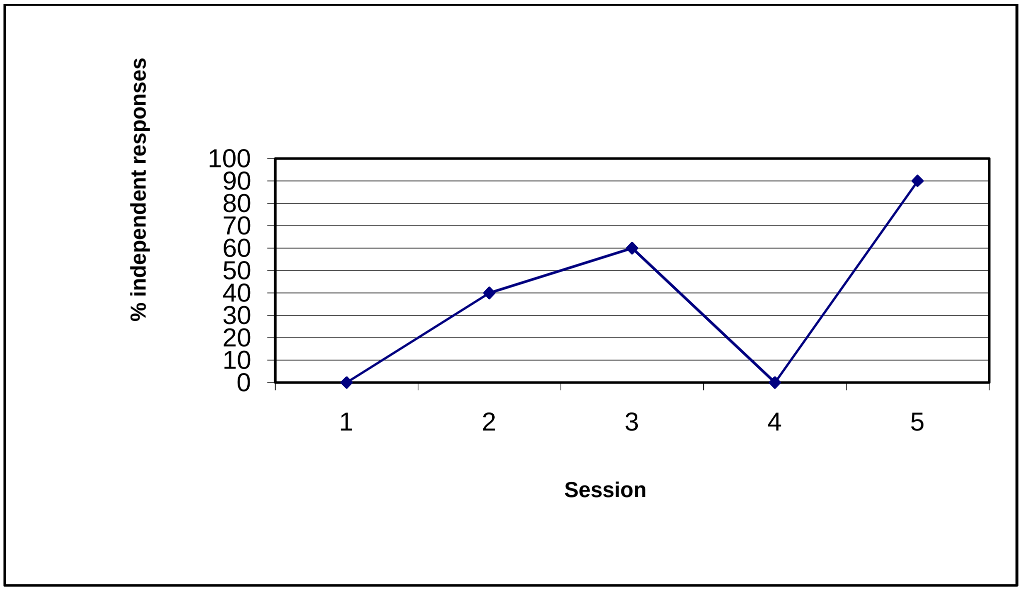


Figure 21. Participant #17b, Year 5, skill = Takes Turns



Year 4 saw gains in 75% of all skills targeted by the teachers as measured by specific skill instruction or pre-post data. Year 5 saw gains in 85% of the skills that were addressed through intervention. By Year 5, all specific skill instruction was conducted by classroom staff. Project staff conducted reliability checks on the specific skill instruction data for five subjects in the model and replication classrooms in Year 5. The mean inter-observer agreement between teacher and project staff ranged from 50% to 100% and averaged 80%.

Overall skill development. Table 11 shows changes in the pre-and post-intervention scores for each child using the new *Hands-On Learning at School*. The mean gain across participants on this instrument was 17% and all participants showed gains of at least 8%.

Table 11. Gains in *Hands-On Learning at School* scores for Year 4-5 participants

Participant	Pre (%)	Post (%)	Gain (%)
16b	78	86	8
17b	73	86	13
18	50	79	29
19a	46	65	19
19b	70	82	12
20	50	67	17
21a	37	59	22
21b	51	74	23
22a	37	51	14
22b	41	54	13
23	60	85	25
24	59	72	13
25	60	77	17
Mean	*55%*	*72%*	*17%*

A small group of children with PDD who were schooled at the Callier Center for Communication Disorders of the University of Texas at Dallas and who were part of the field test of the new assessment instruments also provided a comparison to children participating in the model and replication classrooms. Pre-post data on these children appears in Table 12, below. The mean gain was only 5% using the teacher-administered assessments (*Hands-On Learning at School*). This gain is considerably smaller than that achieved by project participants. Although this is a small sample, it suggests that project participants benefited from the Hands-On Learning intervention.

Table 12. Gains in *Hands-On Learning at School* scores for comparison group

Participant	Pre	Post	Gain
1	21%	53%	32%
2	18%	19%	1%
3	81%	64%	-7%
4	47%	53%	6%
5	26%	31%	5%
Mean	39%	44%	5%

<u>Observational data</u> To bolster the trial-by-trial data with a more objective view of performance, comparisons were made of the Object Interaction code data (described

in Section V) from one tape made at the start of intervention and one made at the end of intervention. These tapes were coded by research assistants who were unaware of the object interaction skills being addressed. Tapes were coded on a modified frequency basis on 60-second intervals, with observers checking off the object interaction skills demonstrated in each interval. Summary measures from this code were described in Section V. Inter-observer reliability on the object interaction code was computed for each object interaction category and on at least 20% of the sessions for each participant. Inter-observer reliability, computed as (# agreements)/(# agreements + # disagreements), averaged 88% for Year 4 and 91% for Year 5 data.

Table 13 summarizes the Object Interaction code data collected on Year 4-5 participants from the pre-post videotapes of their targeted activities. This table provides seven different figures derived from the observational data. The first row shows the mean proportion of intervals that included at least one *cue for object interaction* from the teacher, which increased over the course of the project from .77 to .85. The second row shows the mean proportion of coded intervals that included *any sort of object interaction* on the part of the child, which increased marginally over the course of the project from .93 to .95. (This measure was at almost 100% to begin with, so that there was little room for improvement on this measure.) The third row shows that the mean number of skill *clusters* demonstrated by participants (out of the 14 clusters included in the assessment increased from 5 to 8 per session. The fourth row shows that the mean number of *complex* object interaction skills (see footnote 1) increased from 1 to 2. The fifth row shows that the number of *different* object interaction skills observed within a session increased on average from 7 to 11. The final row shows that the mean proportion of intervals that included object interaction *initiated* by the child (as opposed to produced in response to a teacher's cue). The greatest change, as hoped, was in the variety and complexity of the object interaction skills demonstrated y participants.

Table 13. Pre and post object interaction code data for Year 4-5 participants

Object Interaction Code Variable	Mean Pre	Mean Post	Gain
P(Cues)	.77	.85	.08
P(Object interaction)	.93	.95	.02
# Clusters	.36	.50	.14*
# Complex Skills	.08	.17	.09*
# Different Skills	7	11	4**
P(Initiations)	.83	.84	.01

* Paired samples t - test significant p<.05, ** Paired samples t - test significant p<.01

2. A Closer Look at Social Skill Development

As stated earlier, a major expansion in focus in Years 4 and 5 involved the social use of objects. Further analysis of the coded data from the pre/post videotapes of instructional activities provides evidence of this new emphasis on the social use of objects. Comparison of pre and post scores for both Years 4 and 5 shows a change in the *type* of social interaction as well as in the proportion of intervals involving such interactions. In Year 4, scores from the first of the videotaped sessions showed that only one out of eight (12%) of the participants were demonstrating any of the skills in the Social Uses strand: this number increased to 3 out of 8 (38%) by the final session.

The videotaped data from Year 5 showed dramatic increases in the demonstration of social skills by participants. In that year, 100% of the participants were demonstrating skills from the Social Uses strand at *both* pre and post sessions, showing that these skills were being targeted routinely by teachers in instructional activities by that year. In that final year, the number of Social Use skills observed increased from a mean of 1 to a mean of 3 per participant. There were also differences over the course of that year in the nature of the social skills observed. In the first videotaped session, students were demonstrating only skills that involved the use of objects in the presence of peers, but that did not involve interaction with the peers. By the end of the year, all participants were demonstrating object interaction skills that actually involved interaction with their peers (Takes turns, Plays game with peer, or Cooperates).

3. Environmental Support for Skill Development

D2L was also administered to the pre-post videotapes to assess the degree to which the teaching environment changed across the course of intervention. The mean *D2L* score increased from 49% to 59 % across participants from the beginning to the end of intervention. All eight sections of D2L showed increased scores. The greatest gain occurred in the Opportunities to Use Objects section, which improved by 18%.

VII. Conclusions

This five-year project provided new information about the skills of children with PDD, developed new ways to assess the cognitive and social skills of children with PDD, and showed that object interaction skills that reflect cognitive and social skill development can be taught in typical classroom activities. General findings include the following:

- Object interaction skill levels were lower for children with PDD than for their age peers.
- Children with PDD performed most poorly on Strand IV, Social Uses, as compared to Strands I-III.
- There were high and positive correlations between all four Strands of the assessment instruments for children with PDD (as was the case for children without disabilities). These high correlations suggest that the learning of object interaction skills from Strands I-III might be a promising route to improved skills in Strand IV, Social Uses.
- Children with PDD who had some form of symbolic communication scored significantly higher than did those who communicated pre-symbolically. However, the scores of those with symbolic communication ranged across the entire upper ½ of the score distribution, showing that the instruments are still useful for these children.
- The correlation between Social Uses (Strand IV) and the other three Strands was equally strong (and positive) for children with and without symbolic communication skills. This suggests that object interaction skills may be used to mediate social interaction even in the absence of conventional communication skills.
- It was possible to teach object interaction skills to project participants with PDD using a combination of highly structured (yet always functional) and less structured approaches.
- Project participants were able to learn to use object interaction skills that were progressively more complex and interactive in social contexts involving peers.

- Children with PDD who did not receive the *Hands-on Learning* intervention did not improve in terms of object interaction skills as much as did project participants.

A. New ways to assess the skills of children with PDD

Results from the first three years of the study had prompted the expansion of the original instruments to better accommodate the range of skills demonstrated by children with PDD and also to incorporate the social uses of objects into the skills represented. The revised instruments were field tested in Year 4 on modest samples of children with PDD and children without disabilities. Results revealed a high level of agreement between home and school, suggesting that descriptions of the items were clear to both parents and teachers. The data also showed that the instrument provided test items applicable to any child with PDD within the sampled age range of 2-6 years, with little likelihood of "testing out" of these assessments. The distribution of scores across the sample was fairly even, with most children performing in the mid-ranges. Comparisons of children with PDD to their non-disabled peers highlighted the lower performance of the targeted population across all strands, with greater discrepancies for Representational and Social Uses strands.

The general approach represented by the *Hands-On Learning* instruments emphasizes assessment through the observation of everyday activities and their translation into underlying skills. This approach is similar to "performance assessment", which involves the demonstration of skills in the midst of naturally occurring activities (Silberman & Brown, 1998). LeVan (1990) describes a method of sampling and evaluating child development that he calls "shopping for skills", which relies on the evaluator to search for evidence of developmental skills in the everyday behaviors of children as they interact with familiar materials. The examples for each item in the *Hands-On Learning* assessments (many provided by parents and teachers) describe everyday actions that a typical child might perform with objects found at school or at home. The 39 skills represent underlying generic abilities that are revealed by those examples. *Hands-On Learning at Home & School* might be viewed as shopping lists of cognitive and social skills (represented by the items), with the specific examples showing where the parent or teacher might look to find those skills.

The instruments were designed to be pragmatic in terms of their immediate usefulness for generating instructional objectives. Rather than expressing skills in terms of isolated components such as perceptual discrimination and conceptual development, the *Hands-On Learning* assessments use terminology that is meaningful to parents and teachers. Inspection of data on a child's performance of skills in the four strands readily suggests both emerging skills with which the child needs further practice, and logical new skills to target within each strand. Parents of children with PDD gave the home version of the assessment high marks for its adherence to purpose, ease of understanding and administration, as well as utility in describing their child. Teacher evaluations of the school version were similarly high on these points as well on its value in aiding in the determination of intervention priorities.

B. Instruction

Results of project-supervised instruction showed that children with PDD could be taught to master object interaction skills, including social uses of objects. Skill development occurred across a variety of skills, clusters and strands and greatly exceeded gains in object interaction skills noted in the comparison group of children who did not receive similar instruction. In the final year of the project, all students acquired object interactions skills that were used to mediate progressively more complex interactions with their peers.

As described in the *Hands-On Learning* model, instruction was driven by assessment results gathered from both the home and the school. Side-by-side comparison of learner performance in the two environments presents a complete picture of the learner. This aspect of the model also encourages the collaboration of parents and teachers in setting individualized instructional goals and in determining exactly what form instruction should take. Intervention is always based on highly motivating materials and individualized approaches as described in the Teacher's Guide. The instructional approach combines specific skill instruction with less structured opportunity-driven instruction as captured by the environmental inventory, *Design to Learn*. This approach to instruction is not extremely common in curricula described for this population, which tend to be either very highly structured ones that suppress spontaneity and are lacking in functionality or very unstructured ones that encourage spontaneity but are difficult to define and monitor (Schuler & Wolfberg, 2000).

The *Hands-On Learning* approach emphasizes a logical sequence of instructional targets and the harnessing of the learner's intrinsic motivation to learn. These concepts are compatible with Bailey's discussion of critical experiences and teachable moments Bailey (2002). Bailey suggests a shift in thinking away from the notion of critical periods (which imply that the opportunity to learn may be permanently missed if not provided by a certain age) to "critical experiences". Critical experiences are ones that are essential for children to maximize development. Such experiences may adhere to certain sequences—that is one sort of critical experience may necessarily have to follow a highly related one: but age *per se* is not considered as important as developmental status in relationship to readiness to learn. Teachable moments are related to critical experiences: teachable moments occur when the child is intrinsically motivated to learn something new. The generic object interaction skills targeted by the *Hands-On Learning* approach might be conceived of as critical experiences that may be taught in a logical progression, always structuring learning around contexts and materials that are intrinsically motivating to the learner.

C. The Learning Environment

Observational data taken in Years 1-3 repeatedly showed that opportunities to use object interaction skills could be integrated across a wide variety of daily activities within the preschool classroom for children with PDD as well as for their classmates with or without disabilities. *Design to Learn* was developed to evaluate the extent to which learning environments provide children with opportunities to develop and practice these skills. This instrument has also been field tested with children who have more severe and multiple disabilities and has proven to be a useful adjunct to instruction for these children also, especially when used by teachers themselves. It seems to focus the teacher's attention on aspects of the social and physical environments that encourage learning and serves as a useful heuristic, suggesting teaching strategies other than the typical heavily teacher-directed ones.

Wolfberg & Schuler (1993) and Schuler & Wolfberg (2000) describe techniques for harnessing the play of children with autism for instructional purposes and specifically to target social and cognitive skill development. The *Hands-On Learning* approach also views play as an activity that may be used to scaffold learning of both cognitive and social skills. Our model combines instruction similar to the guided participation in integrated playgroups described by Wolfberg & Schuler with more structured specific skill instruction. Instructional methods vary along a continuum of structure according to the needs of the individual learner. Along the entire continuum, however, the instructional methods always harness the child's' intrinsic motivations, encourage initiation on the part of the child, and target a strategic shift from teacher-directed instruction to opportunity-driven instruction promoted by rich social and physical environments.

The model and replication classrooms with which the project was involved changed from year to year, and ranged from highly structured self-contained settings to the more typical preschool environment found in supported-integrated settings. The *Hands-On Learning* model was successfully implemented across each of these very different learning environments. Furthermore, model implementation was systematically released from project staff to classroom staff over the course of the project. By the final year classroom staff had completely taken over implementation. Thus, the *Hands-On Learning* model was developed, demonstrated and replicated in the "real world" of the typical public school classroom by practitioners themselves amidst all the constraints that characterize a typical day. The project represents a successful attempt to move systematically from research to practice.

D. Future research

This study has raised many questions and suggests a number of different directions for future research. The use of objects to scaffold social interactions for children with social skill deficits merits further attention. An investigation of the variables of task complexity and the development of joint focus related to object interaction would also be useful. The relationship between object interaction skills, cognitive development, social development and communication skill level also deserves a closer look as we develop meaningful instruction that treats the whole learner with PDD. A normative study that affords the opportunity to gather assessment data from a large stratified sample of children with PDD and typically developing children would provide further knowledge about the skills of children with PDD and would further validate the new instruments developed through this project. Finally, an intervention study involving a larger number of children with PDD and a matched control group would provide additional evidence of the effectiveness of the *Hands-On Learning* intervention.

VII. References

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