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Effective Use of Computer-Assisted Reading Instruction: Teacher Scaffolding for Children with Autism

Huang, Cheng-Fang

This study investigates the efficacy of computer-assisted instruction (CAI) with teacher scaffolding as an intervention for children with autism to develop critical early reading skills. The progress of eight preschool children with autism (ranged from mild to severe) is evaluated. The results suggest that for children with mild to moderate autism, the CAI is an effective means to deliver reading instruction when supplemented with teacher scaffolding. The effectiveness of the computer-assisted instruction relies on two levels of scaffolding. First, the computer provides clear and predictable structure, simple but perceptually salient feature, and systematic provision of stimulus, prompting, and reinforcement which corresponds to the learners' general learning characteristics. At a second level, the teacher scaffolding for each learner ensures the success of the instruction because the individualized support meets the diverse needs of the children and flexibly guides the learner toward the higher development of the competence. The functions of the observed teacher scaffolding, evolved from Wood, Bruner, and Ross (1976), include (1) simplifying the task to a child's attainable level, (2) highlighting critical task features, (3) demonstrating solutions/reading practices, (4) maintaining goal direction, (5) controlling frustration with mouse operation, and (6) promoting a child's interest in the task. In summary, when implementing computer-assisted instruction for children with autism, both the computer and the teacher play crucial roles in the success of the instruction. The computer and the teacher should be thought of as complementing each other in order to maximize the learning outcomes of the children.

Keywords:Computer-Assisted Instruction (CAI); Scaffolding; Autism; Sight Vocabulary

Huang, Cheng-Fang, Assistant Professor, English Languages Center, School of Applied Languages, Ming Chun University, Taiwan

Corresponding Author：Huang, Cheng-Fang，e-mail: rebecca@mail.mcu.edu.tw

1. Introduction

Over the past decades, research has shed light on how computer-assisted instruction can enhance students' literacy skills in such areas as reading (Boone & Higgins, 1993), comprehension (MacArthur & Haynes, 1995), study skills (Horton, Lovitt, Givens, & Nelson, 1989), and writing (Dalton, Winburg & Morocco, 1990; Kerchner & Kistinger, 1984). These citations represent a small sample of a rich literature grown in years. Recent research has also documented the benefits of computer-assisted instruction on the attitudes and academic performance of students with disabilities in general (Bosseler & Massaro, 2003; Campbell & Mechling, 2009; Fuchs, Fuchs, Hamlet, Powell, Capizzi, & Seethaler, 2006; Jerome, & Barbetta, 2005; Shimizu, Twyman, & Yamamoto, 2003; Twyman, & Tindal, 2006; Vedora, & Stromer, 2007). However, little has been studied about the effects of computer-assisted instruction on the early reading skills of children with autism.

Research has shown that early literacy development is fostered by rich engagement with literature provided at home, in school, and through communities (Goodman & Goodman, 1979; Whitehurst, Falco, Lonigan, Fischal, DeBaryshe, Valdez-Manchaca, & Caulfield, 1988). Children at this stage accumulate their sight vocabulary through reading familiar words in their favorite books, common road signs, and brand names on packages. These literature experiences involve genuine interaction with adults or older children in exploring the print world. From a Vygotskian perspective, the social interaction between a child and a more competent other allows for the internalization of reading practices and the development of young readers (Gunn, Simmons & Kameenui, 1998).

Children with autism, however, often have difficulties with social interaction, communication, and imitation (Olley & Gutentag, 1999), which, in return, may impede genuine engagement with literature. Another common deficit, stimulus over-selectivity (Lovaas & Schreibman, 1971), of children with autism may also impede early literacy development. While typically developing children attend to multiple stimuli—pictures, texts, sound, gesture—in the learning environment, children with autism, in contrast, tend to focus on limited stimuli, which may possibly be irrelevant to the task of reading. Given these disadvantages, how do they build the same word awareness and sight vocabulary as their non-autistic peers?

Reading intervention provided by computer can be programmed to provide salient stimuli to draw their attention and to restrict confusing cues associated with social interaction. Such learning environment may be more manageable and motivating because it helps children with autism overcome problems, such as, attention, frustration, and poor motivation (Williams, Wright, Callaghan, & Coughlan, 2002). In response to the unique learning characteristics, instruction that has been empirically shown beneficial for children with autism has been derived from applied behavior analysis (Zager, Shamow & Schneider, 1999). The computer-assisted instruction used in the present study also embraces the principles of applied behavior analysis in the design of lesson delivery. Such instructional design appears to afford a structured and consistent learning environment appropriate for children with autism (Panyan, 1984). However, is this software program alone an effective means to deliver reading instruction and to meet unique needs of each child? What is educators' role while emergent readers with autism engage with such reading software?

Research has suggested that the complementary scaffolding provided by the teacher to the computer-assisted instruction might further enhance those developing literacy practices (Heimann, Nelson, Tjus, & Gillberg, 1995; Tjus, Heimann, & Neilson, 1998). To understand how to optimize the learning outcome of children with autism, it is vital to holistically study the role of the teacher in relation to the learning of the children in various situations (Salomon, 1991). This study investigates teacher scaffolding through observing the interaction among the student, the computer, and the teacher while the preschool children with autism engaged in the computer-assisted reading instruction.

2. Literature Review

2.1 Instructional Considerations for Children with Autism

The Influence of Autism on Learning

Autism represents a heterogeneous syndrome exhibiting cognitive inconsistencies, language deficits, communication problems, social impairment, and atypical behavioral rigidity (Olley & Gutentag, 1999). The learning profile usually reflects relative strengths in nonverbal and nonsocial problem solving, such as rule-based tasks, visuospatial organization, and associative memory, while difficulties with verbal reasoning, social and abstract tasks requiring flexibility (Quill, 1997). While typically developing children engage naturally in attending, following directions, and imitating others to acquire linguistic and social skills, children with autism benefit from explicit instruction to acquire these cognitive and social behaviors.

The inabilities to flexibly extract, analyze, and integrate meaning from linguistic and social events are associated with the deficits in attention, information processing, and memory. Children with autism show delays in attention between visual and auditory stimuli, impairments in rapid shifting of attention, and attending to the most salient or meaningful feature of an experience (Ciesielski, Courchesne, & Elmasian, 1990; Frith & Baron-Cohen, 1987). They perform better with visuospatial information, such as discrimination, matching, and block assembly, than auditory information that requires sequential processing (Harris, Handleman, & Burton, 1990; Hermelin & O'Connor, 1970). Similarly, the memory skills, such as rote memory and cued recall, of nonverbal material are relatively superior to memory for verbal and social material (Sigman, Ungerer, Mundy, & Sherman, 1987).

In response to the unique characteristics of cognitive capability, instruction that has been shown to benefit children with autism has been highly structured, individualized, and skill-oriented. Such learning environment has incorporated predictable routines, individualized motivation systems, visual supports for language comprehension and communication (Zager, et al., 1999). Further discussion on effective instruction for children with autism follows in the next section.

Effective Instruction for Children with Autism

Applied behavior analysis (ABA), a treatment modality based on rigorous standard of methodology and design, is effective in treating children with autism (Zager, et al., 1999). ABA-based interventions effectively decrease inappropriate behaviors and increase proper behaviors through utilizing the principles of stimulus, response and reinforcement (Campbell, 2003).

Among the ABA-based interventions, discrete trial teaching is especially effective for teaching new skills, such as cognitive, communication, play, social and self-help skills, to children with autism (Smith, 2001). This teaching approach involves a teacher working one-on-one with a child in a distraction free setting. A new skill is divided into smaller units to be presented and one sub-skill is taught at a time until mastery. During each discrete trial, prompting and reinforcement are provided as necessary (Lovaas, 2003). The advantages of discrete trail teaching include: (1) it provides students with multiple opportunities to practice; (2) it allows the teacher to adjust the pace of the instruction based on individual student's response and progress; (3) each trial is of identical form and contains a clear beginning and end which is more comprehensible to children with autism (Smith, 2001). Despite its effectiveness in teaching children to respond correctly to cues from the teacher, discrete trial teaching does not provide a natural environment for children with autism to initiate or response to uncontrolled cues. They may not be able to transfer newly acquired skills to other settings, such as classrooms or homes.

Incidental teaching approach, however, is particularly helpful for encouraging children with autism to generalize new skills to different settings (Charlop-Christy, & Carpenter, 2000; Miranda-Linne & Melin, 1992). In this approach, the natural environment is arranged to encourage the child to initiate and then the teacher instruct the child in the context by responding to a child's initiated interests or requests with praise, prompts, or modeling. There are several advantages to incidental teaching. First of all, teaching within the context of everyday situations promotes generalization of skills. Secondly, the arrangement of the natural environment enhances the interaction between a child and the adult. In addition, social initiations, a deficit of many children with autism, are integrated into the teaching procedure and thus increase spontaneous use of functional language (McGee, Morrier, & Daly, 1999).

In addition to the previously mentioned teaching approaches, treatment and education of autistic and related communication handicapped children (TEACCH) is another effective integrated program for children with autism (Panerai, Ferrante, & Zingale, 2002). It emphasizes "structured teaching," which refers to using organized physical environments, visual schedules, structured work or activity systems and visually structured activities. The key to effectively integrate each of these components is individualization. Providing organized learning environment and structured activities in each student's comprehendible way can help to alleviate or moderate problems resulted from their deficits and enhance the learning outcomes of children with autism (Schopler, Mesibov, & Hearsey, 1995).

Instructional Principles of Discrete Trial Teaching

Discrete trial teaching provides students with multiple trials to practice and acquire skills. Each teaching trial contains a clear antecedent, student response, and a consequence. The teacher determines the pace of instruction, selects the teaching stimuli, provides prompting or reinforcement according to student response, and records data across teaching trials to evaluate student learning (Zager, et al., 1999).

The second principle of discrete trial teaching is prompting. To assist children with autism to acquire and maintain new skills, it is sometimes necessary to prompt the desired response. Prompting involves hierarchical provision of verbal, visual, gestural, to physical guidance, which will be reduced in frequency and intensity in the process of skill acquisition and removed when independent performance achieves (Moore & Goldiamond, 1964). Although the notion of scaffolding, which will be thoroughly reviewed later, is derived from a different belief—the social psychology, the provision of calibrated assistance in the process of internalization of behaviors seems to bear a resemblance to the prompting procedure in the discrete trial teaching.

The last principle involves reinforcer delivery schedule. In the initial stage of skill acquisition, it is essential to reinforce every correct response, whether independent or prompted. This delivery rule for reinforcement is called continuous reinforcement. As a child consistently making correct response, reinforcement can be provided intermittently (i.e., after some, but not every, correct response). By reducing the frequency and intensity of reinforcement, children learn to maintain newly acquired skills in the absence of reinforcement (Skinner, 1953).

As discrete trial teaching, other successful educational programs derived from applied behavior analysis share the same principles: structured trials, hierarchical prompting, and individualized motivation system. Computer-assisted instruction incorporates these principles in the design of lesson delivery can be a valuable supplement to the existing resource for children with autism (Goldsmith & LeBlanc, 2004).

Computer Assisted Instruction for Children with Autism

Computer-assisted instruction (CAI) is a systematic, piece-wise instructional sequence delivered by computer, which can be beneficial for children with autism (Goldsmith & LeBlanc, 2004). CAI can build on small instructional steps incorporating repetitive trials, prompting, and reinforcement as in the behavioral practices, such as discrete trial teaching. The benefits rest on its predictability and simplicity. Such a consistent learning environment help children with autism to overcome frustration associated with cognitive, social, and communication impairments (Panyan, 1984).

Computers can be programmed to control stimuli and restrict confusing cues, creating a more manageable learning environment than associated with complex social interaction (Williams, Wright, Callaghan, & Coughlan, 2002). Social stimuli, usually complex and transient, are difficult for children with autism to comprehend and to follow. It seems easier for them to process information by focusing on the most critical information presented through perceptually salient stimuli (e.g., visual cues, sound effects) in simple and prolonged fashion (Jordan & Powell, 1990a). Additionally, the visual stimuli provided by computer program can elicit attention and improve retention of information of these children (Moore & Calvert, 2000).

The potential benefits of computer-assisted instruction thus seem to be apparent, however, few empirical studies have examined the feasibility of such instructional medium in learning for young children with autism. The early studies conducted in 1970s, although utilized relatively simple programming, reported improvement in expressive language acquisition (Colby, 1973; Colby & Smith, 1971) and positive results of discriminative skill training (Russo, Koegel, & Lovaas, 1978).

In the past two decades, computers have been used to teach a variety of skills, such as reading and communication (Heimann, Nelson, Tjus, & Gillberg, 1995), verbal imitation (Bernhard-Opitz, Sriram, & Sapuan, 1999), vocabulary (Moore & Calvert, 2000; Bosseler & Massaro, 2003), emotion recognition and prediction (Silver & Oakes, 2001), social problem solving (Bernhard-Opitz, Sriram, & Nakhoda-Sapuan, 2001), and spelling (Blischak & Schlosser, 2003). For example, Bosseler & Masaro (2003) investigated the effectiveness of a computer-animated tutor in teaching vocabulary and grammar to eight elementary children with autism. Results indicated that the students, compared with the pre-test, were able to identify significantly more vocabulary and grammatical concepts during the post-test and to recall 85% of the newly learned items 30 days after the completion of training.

Further investigations on the comparison of computer-assisted instruction with teacher-provided instruction have also been conducted. Chen & Bernard-Opitz (1993) compared computer-assisted instruction to teacher-provided instruction and found better learning motivation and fewer behavior problems with computer-assisted instruction for 3 of the 4 participants. However, there was no significant difference in the participants' learning rates. Moore & Calvert (2000) compared computer-based instruction with a behavioral program for vocabulary acquisition for children with autism. The results showed that children with autism were more attentive, were more motivated and acquired more vocabulary with the computer. Williams, Wright, Callaghan, and Coughlan (2002) found that computer-assisted instruction helped 5 of the 8 children with autism to reliably identify at least 3 words. Additionally, the participants spent more time on reading material through the computer and were less resistant to it.

These comparative studies indicate that under the computer condition, students with autism have performed more appropriate behaviors—reduction in echolalia, improved eye contact, less prompting (Bernard-Opitz, Ross & Tuttas, 1990), less disruptive behaviors (Chen & Bernard-Opitz, 1993), greater motivation (Chen & Bernard-Opitz, 1993; Moore & Calvert, 2000), and longer time on-task (Moore & Calvert, 2000; Williams, et al., 2002). However, while a few claimed better learning results compared to traditional methods (Moore & Calvert, 2000), most research results showed the student performance equivalent for these two teaching conditions (Bernard-Opitz, Ross & Tuttas, 1990; Chen & Bernard-Opitz, 1993; Plienis & Romanczyk, 1985; Williams, et al., 2002).

This phenomenon may relate to some students' inability to work independently with computers (Russo, et al., 1978). Research has suggested that teachers play an essential role in promoting meaningful learning environment for children with autism in computer-assisted instruction (Heimann, et al., 1995; Jordan & Powell, 1990b; Tjus, Heimann, & Neilson, 1998). Under this view that the teacher, the student, and the computer program consist of a whole learning environment (Salomon, 1991), how do aspects of a learning system defined as such contribute to the learning?

2.2 Scaffolding in Teaching-Learning Process

Defining the Metaphor of Scaffolding

Wood, Bruner and Ross (1976) empirically studied and promoted the notion of scaffolding, a process where an expert provides calibrated assistance to a novice learning to carry out a task that is initially beyond his/her capacity. In their own words, the calibrated assistance is described as "adult 'controlling' those elements of the task that are initially beyond learner's capacity, thus permitting him/her to concentrate upon and complete only those elements that are within his range of competence (p.90)." Identified by Wood et al., there are six types of assistance an expert tutor could provide a tutee:

(1) *Recruitment*. The tutor's first and upmost task would be recruiting the learner's interest in the task and willingness to adhere to the task.

(2) *Reduction in degrees of freedom*. This involves simplifying task to learner's attainable level to allow him/her perfect the constituent acts and gradually reach the requirement.

(3) *Direction maintenance*. Once the learner lags or is distracted, the effective tutor could keep the learner in pursuit of the intended goal.

(4) *Marking critical features*. Through highlighting the critical feature of the task, the tutor could make the learner aware of the discrepancy between what he/she has produced and the correct production.

(5) *Frustration control*. By a variety of approaches, the tutor could help reduce the learner's stress and frustration with the task.

(6) *Demonstration*. This involves modeling or explicating an ideal solution to a task, particularly one that has been partially executed by the learner.

Wood et al. (1976) emphasized that scaffolding is more than providing assistance with a difficult task; instead, the process can maximize the potential for genuine mastery of a new skill. This concept has subsequently been elaborated and extended to classroom instruction.

Cazden (1979) used an analogy, the social game peekaboo, to illustrate a mastery process of new ways of talking and thinking scaffolded by the classroom participation structures. When playing peekaboo with their parents, children engage in a clear and repetitive structure, which contains positions (i.e., hiding) and appropriate vocalizations (i.e., hello!). In the beginning, the parent structures the game so that the child can be a successful participant from the beginning. Because the game has reversible role relations, the child is expected to take turns playing the parent's part of the game. Gradually, the child assumes a more and more active role and the parent's assistance diminishes as the child's competence grows. By extension, classroom interactions have a similar repetitive structure where children are expected to gradually master the activity initially modeled by the teacher. As Cazden (1979) stated, this kind of scaffolds provided at home and at school would be better understood through Vygotsky's notion of adult-child interaction in the zone of proximal development.

The appropriate instruction in Vygotsky's view relies on the social interaction that fosters the increasing competence in a child's zone of proximal development. The conceptual origin of the notion of scaffolding is deeply rooted in such belief. It is important to note that the Russian word obuchenie, which is translated as instruction, covers the notion of teaching as well as the notion of learning (Wertsch & Rogoff, 1984). During the teaching-learning process in the zone of proximal development, the adult assesses the child's current understanding of the activity and adjusts the scaffolding to support the child’s participation. The child’s state of understanding and contribution to the activity further guide the adult in constructing the scaffold. Hence, both the adult and the child are actively involved in the teaching-learning process (Rogoff, Malkin, & Gilbride, 1984).

Characteristics of Scaffolded Instruction

The essences of scaffolded instruction are sensitive provision of support and the gradual withdrawal of scaffolding. Four critical characteristics of scaffolding are the child’s ownership of the goals, the appropriateness of the task for the child, calibrated assistance through contingent assessment, and the internalization of the learning (Wertsch & Rogoff, 1984). First key feature of scaffolded instruction is the child’s ownership of the learning goals. It is crucial to establish mutual understanding of the shared goals between the adult and the child as a motivational context for the effective interaction (Fleer, 1992; Stone, 2002). If the child does not understand a goal or does not appreciate it, scaffolding will not work (Hogan & Pressley, 1997). Thus, the adult needs to recruit the child’s interest and maintain joint attention on the pursuit of learning goals (Wood, 1980).

The second feature of scaffolded instruction is the appropriateness of the task for the child (Applebee, 1983). To be effective, scaffolded instruction must consist of goals beyond the child’s current level of achievement but within his/her zone of proximal development. If the goals are not challenging for the child, it is merely skill training instead of scaffolding (Stone, 2002). On the other hand, the child needs to be successful in order to proceed. The adult, therefore, reduces the “degree of freedom” (Wood et al., 1976) of the task and gradually increases it as the child’s competence grows.

The third feature of scaffolding is provision of calibrated assistance through ongoing assessment. During instruction, the adult actively diagnoses the understandings and needs of the child. A wide range of types of support can be provided depending on the child’s current understanding and performance (Rosenshine & Meister, 1992). The adult does not solve the problem or carry out the task while the child passively observes and spontaneously extracts the information. Rather, in the effective use of the zone of proximal development, the adult guides the child through the process, with the child participating at a comfortable but slightly challenging level (Rogoff, 1990; Rogoff et al., 1984).

The fourth critical feature is the child's internalization of the skills or strategies. The scaffolds that the adult provides are temporary and adjustable, allowing the child to "participate at an ever-increasing level of competence" (Palincsar & Brown, 1984). It is important to reduce the support and gradually increase the child's responsibility until he/she can independently perform the task (Applebee, 1983; Hogan & Pressley, 1997; Rosenshine & Meister, 1992; Stone, 1998).

2.3 Scaffolding in Reading Instruction

One canonical example of scaffolded instruction in reading is reciprocal teaching. Reciprocal teaching was first developed by Brown and Palincsar (1984) as an instructional approach to improve students' reading comprehension. The promising result of their first study led to applications in other areas, such as writing, self-regulation, science inquiry, and so forth. Students who participated in Brown and Palincsar's (1984, 1987) studies included at-risk students in the primary grades and remedial readers in middle schools, those of whom have adequate decoding skills but insufficient reading comprehension skills. Small groups of students engaged with their teacher in the joint reading and discussion of expository texts. The teacher and the students took turns leading a discussion about the text with which they were working. The discussion focused on summarizing the text, generating questions from the text, clarifying parts of the unclear text, and predicting forthcoming content based on clues provided by the text. In the beginning of the reciprocal teaching, the teacher assumed major responsibility for leading and sustaining the discussion, and modeling skilled use of the strategies to understand the content. The students were encouraged to participate in the discussions from the very beginning. While each student took his/her turns, the teacher provided assistance as necessary in implementing the strategies. As a student became more competent, the teacher gradually increased the demands, requiring the student to participate at a slightly more challenging level (Palincsar & Brown, 1984; Brown & Palincsar, 1987).

Embedded in Brown and Palincsar's reciprocal teaching are two levels of scaffolds (Stone, 2002). At the broader level, it provides a safe environment for students to contribute even though they are not yet fully competent with the strategies. Its repetitive structure and reversible role relations foster the type of expert scaffolding as in the game, Peekaboo, discussed by Cazden's (1979). At a more specific level, the teacher's contingent guidance for each student ensures the successful development of competence. This type of individualized guidance constitutes the features of scaffolded instruction discussed in the previous section: ownership, appropriateness, calibration, and internalization.

Similarly, the two levels of scaffolding are incorporated in a series of instructional approaches studied by Englert and her colleagues focusing on improving reading skills of elementary and middle school students from special education classrooms. The reading instruction, POSSE (Predict, Organize, Search, Summarize, Evaluate), used reciprocal teaching format for group interactions during instruction and the semantic mapping to make thinking visible to students (Englert & Mariage, 1991; Englert, Tarrant, Mariage, & Oxer, 1994). The macro-level scaffolding, termed "procedural facilitation" by the researchers, includes the "think-sheet" sketching out the POSSE procedure and the cue cards with written prompts, such as "A question I have is …" Procedural facilitation provides a clear structure and practical tools for teachers to explicitly model comprehension strategies and to guide students through the process. The micro-level scaffolding in the POSSE instruction is through teacher's "graduated questions" to bridge between what students know and what they need to know in the group dialogue. As in other scaffolded instructional approaches, teachers need to carefully assess each student's input and to provide calibrated support in the dialogic interaction until internalization is obtained.

The two levels of scaffolding, clear and predictable structure along with individualized supports, was proved to be a significant instructional approach in both Brown and Palincsar's reciprocal teaching and Englert's POSSE study. Brown and Palincsar identified significant increases in the students' ability to use the reading strategies as well as improved comprehension scores on both standardized and criterion-referenced tests. These gains were maintained over time and generalized to situations beyond the research settings (Palincsar, Winn, David, Snyder, & Stevens, 1993). In the POSSE study, students, the majority of whom had learning disabilities, showed significant improvement in recalling of text content and knowledge of comprehension strategies. Regardless of their age levels, the students benefited from the highly prescriptive procedure as well as teachers' provision of fine-tuned supports (Englert & Mariage, 1991; Englert et al, 1994).

2.4 Complementary Roles of Computer and Teacher

As reviewed in previous section, scaffolding generally involves recruitment of the learner's interest in the task, simplifying the task to match the learner's attainable level, highlighting critical task features, demonstrating solutions, maintaining consistent goals, and avoiding frustration (Wood et al., 1976). The computer-assisted instruction under study has incorporated a set of affordance, which functions in approximation of these forms of scaffolding. Under the highly prescriptive structure constructed by the computer-assisted instruction, calibrated assistance provided by the teacher may be a promising complement to form an effective instructional approach. This study is intended to investigate this area and develop guidelines for teachers to optimize computer-assisted instruction for children with autism.

3. Methodology

3.1 Participants and Setting

Eight preschool children ranged in age between 4 years and 5 years 9 months at the start of the study participated. Prior to inclusion in the study, all of the students—7 boys and 1 girl—had been diagnosed with autism and had been receiving specialized programs for children with autism for at least one year. The children were recruited from three schools: Matt, Steve, and Aaron from Child Development Center; Josh, Carl, Roger, and Ken from Dove Elementary School; and Kathy from Sunrise Elementary School (pseudonyms used for all children and schools). The children were selected on the basis of their teachers' recommendation of suitability.

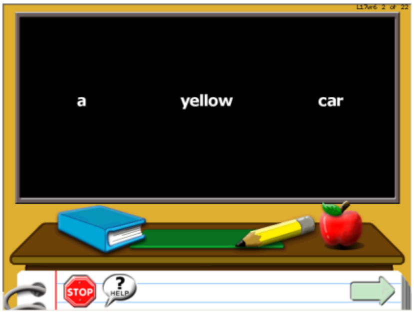
3.2 Program Description

The Edmark Reading Program (ERP) teaches a sight vocabulary of 150 words through a total of 227 lessons. It is designed for the use of one-on-one instruction with each session ranging from five to fifteen minutes. The software is premised with the notion that students learn to read best when the instruction is sequenced through very small steps. All the lessons in the program follow a behavioral model in the delivery of instruction:

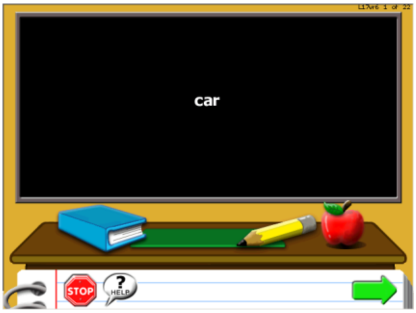
1. Stimulus: A picture, word, or phrase is presented on the screen.

2. Response: The student responds to the verbal instruction.

3. Reinforcement: Positive verbal reinforcement is provided for the correct answer.



A. Word Recognition Task.



B. Word Reading Task

Figure 1 ERP Word Recognition Lesson

3.3 Procedure

All computer-assisted instructions with Edmark Reading Program were conducted in the corner of the child's classroom where the computer located. All the students used the Edmark Reading Program (ERP) 2 to 3 days a week for 10 weeks under the supervision of the researcher. Each student progressed at his/her own pace.

Prior to the reading instruction, all students were given the ERP pre-test, a criterion-referenced test, which consisted of the first 10 words that would be taught in the reading section. They were asked to read those words aloud one at a time (Figure 2). The pre-test provided the baseline information. The students were allowed to skip the word recognition lessons of the words they successful read in the pre-test. Over the course of 10 weeks most students completed 11 to 22 reading lessons following the sequence predetermined by the computer program.

Figure 2 ERP Pre-Test & Post-Test

One week after the students completed the last reading session, the post-test of ERP, a criterion-referenced test, was administered to assess sight word reading fluency of the words learned in the reading lessons. In the ERP post-test (Figure 2), students were asked to read aloud the words they had learned one at a time. Therefore, each student was given different numbers of words. Six weeks after the post-test was administered, the follow-up test, the same format as the post-test, was administered to evaluate the maintenance of sight words learned in the ERP.

3.4 Data Collection

Two categories of data set were collected: (1) background information of the children's development, and (2) the children's ERP performance. Background data included information from the school record and observation of classroom performance. The data of ERP performance included participant observation of interaction, computer record of progress and score, and the result of ERP built-in tests (discrimination test, and pre-, post-, and follow-up tests).

3.5 Data Analysis

All the data collected on each student were analyzed qualitatively for themes and recurring patterns. Within-case analysis was conducted first. Once the analysis of each case was completed, cross-case analysis was conducted both within and across each of the three groups categorized by level of severity in autism spectrum.

A mixed methods analysis was pursued; both quantitative and qualitative data were used to examine the effects of computer-assisted instruction. Each student's scores on the ERP pre-, post-, and follow-up tests provided a measure of the acquisition and maintenance of sight vocabulary recognition. Each student's errors and responses were qualitatively analyzed and interpreted to identify underlying deficits and strengths in order to better understand the reading process and degree of literacy. This analysis was complemented by an analysis of the performance on the early literacy test, ERP discrimination test, and the practices in the school to provide a more holistic view of development.

The unit of analysis associated with the effect of scaffolding included the student, the computer, and the teacher. The students' responses to the reading instruction were analyzed to gain insight into the effectiveness of computer affordance. The assistance provided by the teacher was coded and analyzed into different categories of scaffolding. The relations of the computer affordance and teacher scaffolding were connected through contextual analysis. The data were used to identify pedagogical knowledge in order to optimize teacher/computer-assisted instruction for children with various degrees of autism.

4. Findings and Discussion

4.1 Student Profiles

Based on the school records and class observations, students' developmental profiles are summarized. The severity of the impairment in the areas of social development, communication, and behavioral rigidity are used to divide the eight preschool students into three groups (from mild to severe on the autism spectrum): Group A—mild; Group B—moderate; Group C—severe.

Table 1 Student Developmental Profiles

Group	Name	Age	Cognitive	Language		Communication Issue	Social	
				Rec.	Exp.		Key Issue	Play Skill
A	Matt	5:9	Normal	Normal		Expressing Frustration	Conflict Resolution	Imaginative Play
	Josh	4	Normal	Normal		Selective Mutism	Extreme Shyness	Associative Parallel Play
	Steve	5:6	Normal	Normal		Topic Maintenance	Peer Interaction	Associative Parallel Play

	Carl	4:9	Normal	Normal		1. Expression 2. Conversation	Impulsivity	Parallel Play
B	Roger	4:9	Normal	Delay	Sign. Delay	Limited Verbal Communication	Withdrawal	Solitary Play
	Aaron	5	Normal	Delay		Monologue	1. Resistance to Change 2. Sensory Sensitivity	Solitary Play
	Ken	5:6	Normal	Delay		Echolalia	1. Transition 2. Stimulatory Behavior	Solitary Play
C	Kathy	5	Sign. Delay	Significant Delay		Limited Verbal Communication	1. Withdrawal 2. Stimulatory Behavior 3. Sensory Sensitivity	Exploratory Play

4.1.1 Group A

The students of Group A are Matt, Josh, Steve, and Carl, characterized by their relatively higher social, language, and communication developments, and greater behavioral flexibility. In the area of social development, they are more active in seeking social interaction. They are able to initiate social contact, but often lack the understanding and skills to properly initiate or carry through the social activities. In the area of language and communication, their language developments are within normal range and they possess higher degree of verbal communication skills. In the area of behavior rigidity, the rigidity often appears in obsessive interests or resistance rather than in overt repetitive actions or self-stimulatory behaviors.

Social Development

Matt, Josh, Steve, and Carl all had certain degree of difficulties understanding emotional expression. They were able to identify some emotion of self and others, most often happy, sad, and mad, but were usually unable to provide further description, such as the reason for the emotion. With teacher facilitation, they would engage in directed cooperative play, imaginative play, and turn-taking activity with their peers. Without assistance, they usually engaged in parallel play to associative parallel play.

Among the four students, Matt appeared to perform better interpersonal skills. He was more flexible in applying social skills in different situations. He possessed finer imagination and imitation abilities. Therefore, he could easily engage in pretended play and imitates adults' or peers' behaviors. However, under stressful or conflicting situation, he often employed inappropriate means, such as crying or yelling, to express his frustration and anger. In contrast, Josh was a very quiet and shy student. He became extremely intimidated when an unfamiliar person was around. To develop a new interpersonal relationship with Josh took a considerable amount of effort and time.

Steve applied social skills better in a more structured environment. Sometimes he naturally engaged in associative parallel play with peers, while other times he played alone. He was able to initiate conversation with an adult, but had difficulties sustaining the topic of the conversation. Carl also had difficulties with conversation. Additionally, Carl needed to acquire skills to appropriately initiate social contact with peers. Carl rarely engaged in associative parallel play, but parallel play. He enjoyed imitating behaviors of the adults. His main difficulty was properly controlling his behaviors under impulsion.

Language and Communication

The language development of Matt, Josh, Steve, and Carl were within the normal range. In spite of their relatively higher language skills and innate desire to develop social relationships, they all lacked certain degree of pragmatic communication skills to do so successfully. For instance, they were all unable to expressing their emotion and to understand others' emotional expression.

Matt and Josh were able to engage in conversation with teachers and peers. With anyone, Matt was able to engage and disengage in conversation appropriately. Yet, he was unable to express his anger and frustration through appropriate verbal expression. Josh would become muted when unfamiliar people communicated with him. He only communicated with very familiar people, such as his teachers, some classmates, and parents.

Steve and Carl had more difficulties successfully engaging in conversation. Steve's difficulties exhibited in the areas such as appropriately initiating conversation, retrieving proper answers, and staying on a topic. He sometimes recurrently asked the same questions. In addition to such odd discourse pattern, Steve produced some speech sounds incorrectly, which was anther barrier for successful communication. Carl's verbal communication consisted of single word or short phrases, such as "Story!" instead of a complete sentence, such as, "I want a story." Sometimes he imitated the speech he heard and was able to apply it in correct situation. Visual cues and social stories had been useful tools to help him communicate and gain information.

Behavioral Rigidity

Matt had not yet displayed obvious behavioral rigidity, such as obsessive interests, resistance, or ritualistic behaviors. As to Josh, he highly resisted interacting with unfamiliar people in any way. Steve displayed some degree of rigidity in his restricted interests in letters, words, and art. Carl displayed more serious obsession in his interest in mechanical device. He was compulsive to touch or manipulate the objects.

Cognitive Development

Matt, Josh and Carl were able to learn new things quickly; Steve and Carl possessed very good rote memory. All four students were able to learn most cognitive concepts, such as shape, color, and weather, in the preschool curriculum. Their cognitive developments were within the normal range. The major difficulty they all have was recalling or sequencing personal events.

4.1.2 Group B

The students of Group B are Roger, Aaron, and Ken, characterized by their moderate impairment in social, language, and communication developments, and apparent behavioral rigidity. In the area of social development, they were passive in social contexts and rarely initiated interaction. The delay in language development and impairment in communication skills were noticeable. In terms of rigidity, they manifested ritualistic behaviors, relied on routines, and displayed impoverished imagination.

Social Development

Roger, Aaron, and Ken had poor understanding of social rules. They avoided eye contact. They did not voluntarily engage in social interaction. With teacher direction, Roger, Aaron, and Ken were able to participate in associative parallel play and turn-taking activity with the peers, but not imaginative play. Without assistance, they usually engaged in solitary play or wandered around.

Roger had limited verbal communication ability. He rarely greeted people through either verbal or non-verbal expression. In contrast, Aaron and Ken was able to greet people using patterned communication, such as, "Hi, how are you doing?" or "Hi, (name)." In the situation where they needed assistance, Roger rarely attempted to request it, whereas Aaron and Ken were both able to make their needs known to the adults. In a structured environment with familiar teachers and peers, Roger, Aaron, and Ken would attempt to participate in the activities. Depending on the activities, Roger and Aaron might need some teacher assistance. Ken, on the contrary, needed constant assistance from the teacher to facilitate his participation.

Language and Communication

The receptive language delay of Roger, Aaron, and Ken resulted in the difficulties of understanding and following complex directions, comprehending and learning new subject contents, and acquiring information. Their expressive language delay resulted in the difficulties of expressing ideas, asking and answering questions, and maintaining conversation.

Aaron and Ken often engaged in monologue and echolalic speech. Aaron was able to employ full sentences while Ken used phrases to communicate needs. In contrast, Roger depended primarily on gestures and communication devices for communication. When attempting to speak, Roger produced intonation and segments of words.

Behavioral Rigidity

Roger did not exhibit salient behavioral rigidity, whereas Ken and Aaron both displayed certain degree of stereotyped behaviors and resistance to transition to new situation. Ken's difficulty with transition from an activity he enjoyed was expressed through continually gazing the objects associated with the previous activity. Quite often, he engaged in self-stimulatory behaviors (e.g., rocking back and forth).

Aaron tended to be very anxious in new situation. He was intimidated when an unfamiliar person was around and would avoid interaction with such person. He had difficulties to situations when he was required to be flexible and would express his frustration by increased body movement (i.e., running, arm flailing) as well as crying and consistent refusal of adult direction. Furthermore, he was very sensitive to physical contact and noise, selective about food, and disliked haircuts and wearing socks.

Cognitive Development

Roger, Aaron, and Ken were able to learn most cognitive concepts in the preschool curriculum. They all possessed excellent rote memory, but were unable to recall personal events, understand emotion, and generalize acquired skills. Ken had comparably short attention span: he consistently needed adult direction to remain on task even with activities he enjoyed.

4.1.3 Group C

The student of Group C is Kathy, characterized by her significant impairment in social, language, and communication developments, and severe behavioral rigidity. Socially, Kathy avoided social interaction and was withdrawn into self-stimulatory world. Her social skills included respond with eye contact when her name was called, return greeting by waving her hand, and staying with peers in proximity during group activities. Her play skills were limited in exploring and manipulating objects.

Kathy’s language and communication development was significantly delayed. Her ability of verbal communication was limited. She was only able to say a few words. Her communication relied on Picture Exchange Communication System (PECS) and her body language.

The behavioral rigidity was observed in three areas. First, Kathy substantively engaged in stereotyped, repetitive motions, such as finger twisting or flicking carried out near the face. Secondly, she had intense attachment to restricted objects, such as ribbons, toys that played music, or un-blown balloons. Thirdly, she was extremely stimulus over-selective—she disliked wearing shoes or socks whether in the classroom or the play yard.

Kathy’s cognitive development was also significantly delayed. Her understanding of most concepts in preschool curriculum was limited. She needed teacher assistance to complete most classroom tasks. She lacked the generalization skills to apply acquired skills in a slightly different situation.

4.2 Student Performance

Comparison of student performance in the following areas is discussed: (1) ERP pre-reading instruction, (2) ERP discrimination assessment, and (3) ERP reading instruction.

ERP Pre-Reading Instruction

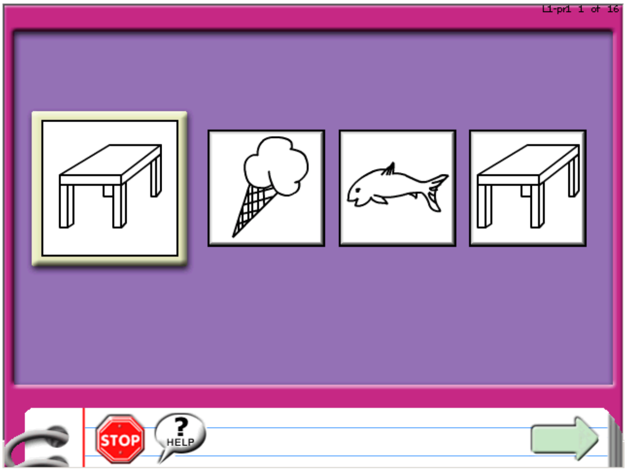


Figure 3 ERP Pre-Reading Lesson

The ERP pre-reading lessons (Figure 3) were used for two purposes. The first purpose was for the student to demonstrate prerequisite ability for sight word reading, which was to match identical configurations. All seven students in Group A and B possessed the ability to differentiate sample configuration from similar drawings, letters, and 2- to 5-letter words in the pre-reading lessons, indicating that the instruction was not challenging for them. All but Ken, completed the majority of the lessons with 100% accuracy. Five of these students, Matt, Steve, Carl, Roger, and Aaron, made no more than 1 error within a lesson, whereas Josh made 3 errors in the only lesson without perfect score. The student in Group C, Kathy, exhibited the ability to discriminate sample configuration from similar concrete pictures (i.e., butterfly, bed, sun), abstract pictures (i.e., lines, curves), and letters, but had not successfully performed the task of matching 2-letter words.

The second purpose was for the student to be accustomed to following the multi-step process with computer verbal direction. The students in Group A required less teacher assistance and quickly became accustomed to the procedure than the students in Group B. By the end of the pre-reading instruction, all students, except Ken (Group B) and Kathy (Group C), were able to independently control the computer mouse and follow the verbal instruction of the computer. Ken continued to require the teacher to operate the computer mouse in order to concentrate on the instruction. Kathy required the teacher to provide verbal direction, to activate her selection on the touch screen, and to reinforce her correct response with verbal praise and contingent reward.

ERP Discrimination Assessment

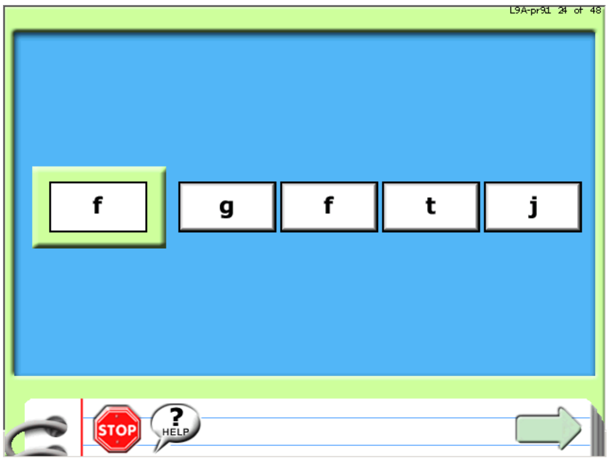


Figure 4 EPR Discrimination Test

Two discrimination tests (Figure 4) concluded the pre-reading lessons by assessing the student's ability to match letters, numbers, and words. The task was more difficult than that in the pre-reading lessons due to (1) the higher level of similarity between the sample item and the answer choices and (2) the increased number of answer choices (from 3 choices in pre-reading lessons to 4 choices in discrimination test). Because of the time constraint, the students (Group A and B) were only given the first discrimination test. The score and the errors of each student were listed in Table 2.

Table 2 ERP Discrimination Test Result

Group	**Name**	**Raw Score**	**Accuracy**	**Sample Item**	**1st Error**	**2nd Error**
B	Roger	23/23	100%	N/A	N/A	N/A
A	Steve	21/23	91.3%	**ca**r	**ca**t	
				fruit	**fr**ame	
A	Matt	19/23	82.6%	**ligh**t	**high**	
				tree	**tr**ain	
				fruit	**tru**th	
				girl	**g**lad	
A	Josh	16/23	69.6%	**e**ye	**e**ar	
				car	**c**ry	**ca**t
				fish	**fas**t	
				the	her	**t**en
				fruit	**tru**th	
				blue	**bl**ack	used
				boy	**b**ye	**bo**ne
B	Aaron	15/23	65.2%	p	q	
				b	d	
				car	**ca**t	
				tree	**tr**ain	
				fish	**fas**t	
				spoon	**sp**ace	**s**oap
				b**o**y	y**o**u	
				run	**ru**le	**r**ed
B	Ken	Incomplete	N/A	N/A	N/A	N/A
		*16/25	64%	N/A	N/A	N/A
A	Carl	Incomplete	N/A	N/A	N/A	N/A

* Ken did not complete the first discrimination test, but the second discrimination test. The test was administered by the teaching assistance and no observation data was available.

The results of the discrimination test showed the individual differences in the student's ability to cautiously distinguish letters and words. Roger (Group B) was the only student who completed the test with no errors. The other students, except Aaron, made no mistake matching letters but made various numbers of errors matching words. It seemed that the students were inclined to attend to word segment, particularly the initial part (e.g., tree vs. train), and sometimes to the contour of the word (e.g., fish vs. fast). It also indicated that not all students readily distinguished reversed letters, such as b vs. d, p vs. q, f vs. t, or n vs. u.

ERP Reading Instruction

All seven students in Groups A and B received reading instruction in the Edmark Reading Program. The learning outcomes of six of the students were similar. First, these six students, Matt, Josh, Steve (Group A), Roger, Aaron, and Ken (Group B), followed the lesson sequence in Edmark Reading Program at their own paces. All of them completed the majority of the lessons with 100% accuracy, while in the remaining lessons they all managed to make no more than two errors within one lesson. Second, their sight vocabularies were expanded after the reading instruction (Table 3). No significant difference was found between the performance of the six students in Group A and Group B. This indicated that Group A and Group B were equally capable of acquiring the reading skills through the software.

Table 3 Quantitative Information of ERP Tests

Group	**Name**	**Pre-Test (correct #)**	**Post-Test**		**Follow-up Test**	
			Correct	**Incorrect**	**Correct**	**Incorrect**
A	Matt	2	8	1 (fish)	8	1 (fish)
	Josh	2	9	0	*N/A	N/A
	Steve	7	12	0	12	0
	Carl	8	*N/A	N/A	N/A	N/A
B	Roger	0	1	11	2	10
			*12	0	*12	0
	Aaron	0	8	0	7	1 (ball)
	Ken	3	27	2 (the, in)	*N/A	N/A

* Josh and Ken did not attend the summer program, when the follow-up test was administered; therefore, the data was unavailable.
* Carl already possessed superior reading competency. He recognized at least 94 words in the Edmark Reading Program. Because the tests would not adequately reflect what he learned from the software, Carl was not given the post- and follow-up tests.
* Roger, because of his limited verbalization, was given an alternative test: word recognition instead of word reading; he recognized all 12 words in post and follow-up tests.

The performances of Carl and Kathy were different from the six students mentioned above. Carl had recognized a great amount of words and was able to learn a new word quickly. The focus of his instruction was, therefore, on word, phrase, and sentence comprehension to assure that he understood what he read. Kathy, on the other hand, did not proceed to the reading instruction. She was not totally ready for word reading instruction. Teaching Kathy to recognize the letters of the alphabet would be a logical and beneficial step prior to giving her such reading instruction.

4.3 Computer Affordance

The instructional design of Edmark Reading Program seems rooted in the tenets of behavioral psychology. As shown in Figure 5, each task within the ERP lesson follows the stimulus-response-reinforcement model. After the computer presented a task to the student, there are three possibilities:

1. If the student responded correctly, the computer provided positive verbal reinforcement.

2. If the student made no response, the computer repeated the direction.

3. If the student responded incorrectly, the computer provided visual cues and verbal prompts to help until the student responded correctly.

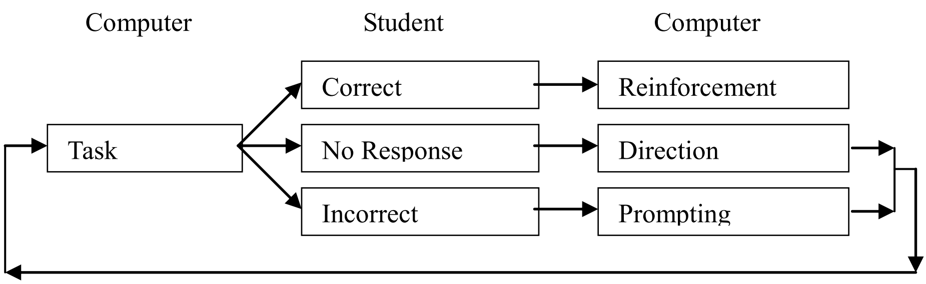


Figure 5 ERP Stimulus-Response-Reinforcement Model

Edmark Reading Program shares many commonalities with discrete trial teaching, one of the effective instructional methods for children with autism. First of all, both ERP and discrete trial teaching require the student to practice and acquire skills through multiple trials. Each teaching trial contains a clearly presented stimulus, student response, and a consequence. Student response to each trial is recorded to evaluate student learning.

Secondly, both ERP and discrete trial teaching utilize prompting to assist the student in acquiring and maintaining new skills. Prompting in discrete trial teaching, however, is more hierarchical. After instructional stimuli were presented, the general procedure in discrete trial teaching was as follows:

1. The student is allowed to respond without assistance.

2. If the student makes no response or incorrect response, another verbal cue is provided.

3. If no response or incorrect response, the correct response is demonstrated and then the verbal cue is repeated.

4. If no response or incorrect response, the student is physically guided through the correct response.

The intensity of prompting increases from no assistance to verbal cue, to demonstration, and finally to physical guidance. In contrast, the prompting of ERP was as follows:

1. The student is allowed to respond without assistance.

2. If the student makes no response, another verbal cue is provided.

3. If the student makes incorrect response, the incorrect response is removed and then the verbal cue is repeated.

4. If the student continually makes incorrect response, eventually the correct response is the only remaining selection and then the verbal cue is repeated.

The prompting technique in ERP involved repetition of verbal cue and gradually simplified visual display.

Finally, both ERP and discrete trial teaching involve reinforcement of correct response, but utilized different reinforcer delivery schedules. The delivery rule used in ERP is continuous reinforcement, where every correct response is reinforced. In the discrete trial teaching, such delivery rule is only used in the initial stage of skill acquisition. As the student consistently making correct response, reinforcement is delivered intermittently by gradually reducing the frequency and intensity of reinforcement. In discrete trial teaching, it is essential for the student to learn to maintain newly acquired skills in the absence of reinforcement.

Students in Group A (Matt, Steve, Josh, Carl) and B (Roger, Aaron, Ken) were capable of following the direction, prompting, and reinforcement delivered by ERP.

As the task was presented, they followed the computer direction to respond. If they made errors, the visual and verbal cues effectively prompted them for correct response. When they made correct responses, the verbal praise the computer provided positively reinforced their behaviors.

In contrast, the student in Group C (Kathy) was unable to follow along. First of all, she did not respond to the computer directions. The teacher needed to simplify the verbal directions to a level understandable to her. For example, the directions were changed from “Click on the picture” to “Touch picture” and “Click on the one that is the same” to “Match.” Secondly, the computer prompting did not achieve the desirable results. For instance, the student was provided with color cue to distinguish between correct and incorrect responses. Immediately after a selection was made, if it was the correct response, the selected item turned green; however, if the incorrect response, it turned red. For Kathy, either color would be a stimulus to reinforce her behavior. That is, seeing a selected item turned green or red had the exactly same effect. Thirdly, the positive verbal reinforcement alone was insufficient. Kathy still heavily relied on tangible items as reinforcement. Some of the effective reinforcers used by the teacher included Sprite, M&Ms, ribbons, unblown balloons, and musical toys.

In summary, the computer affordance was useful for students in Group A and B. However; it was ineffective for the student in Group C because of her limited vocabulary knowledge and difficulties with pragmatics. The inflexible vocabulary knowledge of the student impeded her understanding of the computer direction. To engage in the learning activity, she needed the teacher to “shift” (Stone, 2002) the vocabulary used in the direction. Similarly, she had difficulties understanding the pragmatic intent of the nonverbal cue (i.e., color) of the computer. The meaningful participation in the computer-assisted instruction was limited without additional teacher scaffolding.

4.4 Teacher Scaffolding

During the ERP instruction, the teacher accompanied the student to support the learning when needed. Derived from Wood, Bruner, and Ross’ (1976) categorization, the forms of such teacher scaffolding employed included (1) simplifying task to child’s attainable level, (2) highlighting critical task features, (3) demonstrating solutions / reading practices, (4) maintaining goal direction, (5) controlling frustration with mouse operation, and (6) promoting child’s interest.

The term, scaffolding, is considered as developmentally calibrated assistance provided during the teaching-learning process. Both the teacher and the student contribute in the process of instruction, learning, and development. The teacher assesses the student's current understanding of the activity and adjusts the scaffolding to support the student's participation. The student's state of understanding and response to the activity further guide the teacher in constructing the scaffold (Rogoff, Malkin, & Gilbride, 1984). Using above principles, the teacher-provided scaffolding were examined by looking at the interaction among the student, the computer program, and the teacher. Table 4 listed the forms of teacher scaffolding provided for each student during the ERP instruction.

Table 4 Teacher Scaffolding During ERP Instruction

Group	**Name**	**Simplifying Task to ZPD**	**Highlighting Task Features**	**Modeling Reading / Solution**	**Maintaining Goal Direction**	**Controlling Frustration with Mouse**	**Promoting Interest**
A	Matt	N/A	Confusing Sequence	N/A	N/A	N/A	Token System
	Josh	N/A	N/A	N/A	N/A	N/A	N/A
	Steve	N/A	Confusing Sequence	Left-to-Right Norm	Verbal Prompt	N/A	Token System
	Carl	N/A	N/A	N/A	Verbal Prompt	N/A	N/A
B	Roger	N/A	Complex Sequence	Oral Reading	N/A	Mouse Clicking	Verbal Praise for Reading
	Aaron	Familiarize with Computer	Complex Sequence	Left-to-Right Norm	N/A	Mouse Clicking / Movement	Verbal Praise for Reading
	Ken	N/A	Complex Sequence	Plural Ending	Verbal / Gestural Prompt	Teacher Operate Mouse	Verbal Praise
C	Kathy	Transition Session	N/A	Physical Guidance to Solution	Verbal / Gestural Prompt	Touch Screen / Teacher Operate Mouse	Tangible Reinforcer / Verbal Praise

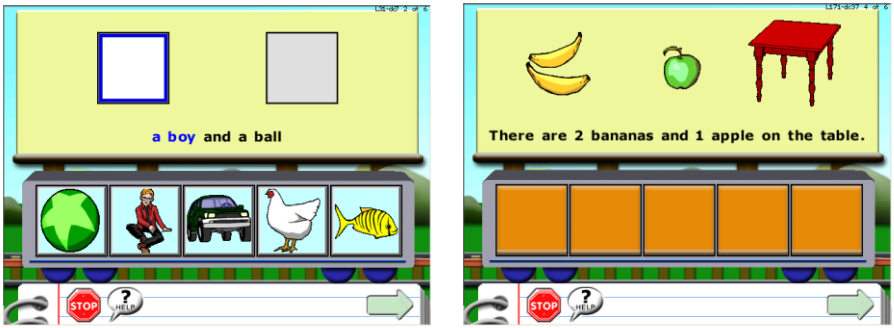
Group A

All the students in this group enjoyed using the computer, but not all of them showed enthusiasm toward the Edmark Reading Program, particularly its repetitive parts. The software program by itself was motivating for both Josh and Carl. Matt and Steve, however, needed additional incentive—a token system—to motivate them for desirable learning behaviors. This contradicted the finding of previous research on that the student was more motivated and enthusiastic with the computer-assisted instruction (Chen & Bernard-Opitz, 1993; Moore & Calvert, 2000). For Matt, the ERP might be more motivating if allowing to reduce the repetition. For Steve, who was very interested in graphic, it would be more motivating if the software were more interactive. Further research in this area is needed to address the variation in children with autism.

During the computer-assisted instruction, this group of students was capable of accomplishing the task with least teacher scaffolding. Each type of the scaffolding would be examined in the following discussion.

<u>Simplifying Task to Child's Attainable Level</u>: The teacher did not provide this type of scaffolding for this group.

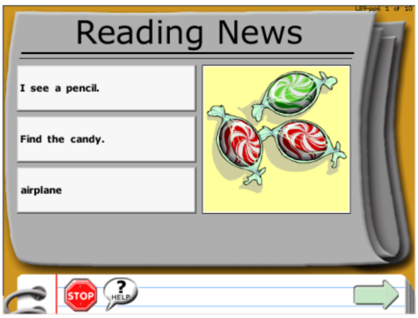
<u>Highlighting Critical Task Features</u>: This type of scaffolding was observed during the word comprehension lessons (Figure 6). Matt and Steve tended not to follow the sequence prompted by the computer when the task involved two sets of word-picture matching. The teacher responded with verbal prompt to "mark critical features" (Wood, et al., 1976) so that the students would pay attention to the correct sequence. Both students were able to achieve increasing independence with the sensitive guidance of the teacher.



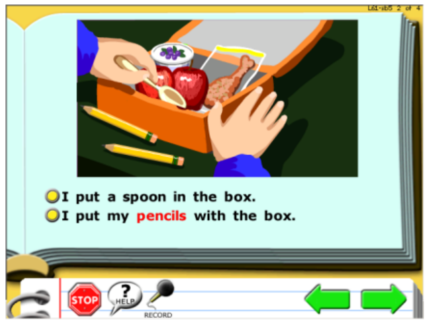
A. Picture-to-Word Matching Task.　　B. Picture Dragging Task

Figure 6　ERP Word Comprehension Lesson

Demonstrating Reading Practices: The teacher provided finger pointing to model reading from left to right. As Steve internalized the cultural norm of reading, the demonstration and prompting from the teacher was gradually removed. The teacher successfully fostered the development of a reading norm that was not initially practiced by the student through demonstration ideal action (Wood, et al., 1976).



A. Phrase -to-Picture Matching Task.



B. Story Reading Task

Figure 7 ERP Reading Lesson

Maintaining Goal Direction: No assistance was needed in this area except for the occasional verbal prompting provided to direct student's attention.

Controlling Frustration with Mouse Operation: No assistance was needed in this area except the explanation of how the mouse worked during the first computer session. Two potential hurdles were observed. First, the standard computer mouse could be too large to grip by these preschoolers. Second, clicking only the left button of the PC computer mouse could be challenging. All students managed to use the mouse without frustration. Steve sometimes adapted to use both hands to operate the computer mouse—one hand moving the mouse and the other hand clicking the left button.

Promoting Child's Interest: Because the computer program did not provide reinforcement for reading, the teacher verbally praised the student to encourage their engagement in reading. Initially, verbal praise was immediately delivered after the student correctly read the words. Progressively, it was sufficient to deliverer the verbal praise intermittently—after several trials. Carl was the exception. He seemed to expect extensive verbal reinforcement from the teacher. Many times after he completed a trial, he looked and smiled to the teacher seemingly to wait for verbal praise. Upon the teacher praise was provided, he moved on to the next trial. In addition, Carl often provided himself reinforcement for his responses. When he made correct responses, he clapped and said, “Good job!” or held both arms up and said, “Yeah!” When he made error responses, he would say, “Oh-oh, try again.”

Group B

All the students in this group enjoyed using the Edmark Reading Program, which might be associated with its repetitive nature, predictable structure, (Jordan & Powell, 1990a) and salient visual stimuli (Moore & Calvert, 2000). Compared to Group A, this group of students was more motivating by the software itself, but they required more intensive teacher scaffolding accomplishing the task during the computer-assisted instruction.

Simplifying Task to Child’s Attainable Level: Because of Aaron’s strong resistance to new experience, he needed intensive teacher guidance during familiarization period with the computer program. During the first few lessons, the teacher coached him how to use the technology by dividing the task to its sub-steps (Wood, et al., 1976). As he progressed to the reading lessons, he was more accustomed to the computer program and more capable of following the direction on his own.

Highlighting Critical Task Features: This type of scaffolding was provided more often to the students in this group than Group A. In the lessons where the procedure was more complicated, they often needed to be guided through the process several times. As they became capable of following such complex sequence, they sometimes needed the teacher prompting in certain confusing parts, such as the sequencing in the word comprehension lesson.

Demonstrating Reading Practices: For different children, this type of scaffolding was provided for different task. For Roger, the assistance was mainly on coaching him to read the words aloud. As Roger read more words, the teacher gradually withdrew the modeling. In spite of his difficulty with enunciation, the frequency of reading behavior progressively increased. For Aaron, teacher modeling was provided to demonstrate left-to-right reading norm. Aaron was able to gradually internalize the reading norm and apply such practice when he read.

Maintaining Goal Direction: Ken was given more substantial teacher prompting than Roger and Aaron due to his frequent off-task behavior. The teacher consistently used the cursor pointing to direct Ken’s attention. For instance, the cursor pointing to a word was used to prompt him to read. The teacher also verbally directed Ken to respond when he was off-task. Occasionally, the teacher needed to redirect him from engaging in self-stimulatory behavior (i.e., looking at his reflection on the monitor) to the task.

Controlling Frustration with Mouse Operation: Each of the students in this group experienced certain level of difficulties while operating the computer mouse. Different level of support was provided to reduce the frustration (Wood, et al., 1976) because of the mouse operation. Roger quickly mastered the skills to move the mouse. The major problem for him was to lift his fingers up after pressing the button of the Mac computer mouse. The teacher verbally reminded him to lift up fingers when he was unsuccessful with the clicking motion. Aaron had difficulties with smoothly moving the mouse and clicking only the left button. Most of the times, the verbal direction provided from the teacher was sufficient to help him. Other times, when he was too frustrated with the mouse, the teacher need to physically guide him through the process. Ken was not allowed to operate the computer mouse because he could not concentrate on the task once he held the mouse. The teacher controlled the mouse and often used the cursor to direction his attention.

Promoting Child's Interest: Teacher provided positive reinforcement was critical for this group. In the reading lessons, verbal praise and patting on the back were often provided after Roger attempted to read the words. The encouragement of his attempt (Stone, 2002) along with the teacher demonstration (Wood, et al., 1976) mentioned previously critically enhanced his reading behavior.

Teacher praising was also very effective for Aaron. A significant amount of praises were provided when Aaron was learning how to use the computer. Initially, when Aaron successfully accomplished a small step, the teacher immediately provided verbal praise. As Aaron was more capable of following the direction and paying attention to the praise from the computer, the teacher provided verbal praise decreased. In addition, Aaron was consistently provided with verbal praise for reading, which was crucial in enhancing his reading behaviors.

For Ken, in all reading lessons, praises from the teacher were provided almost after each correct response (i.e., reading, matching, etc.) to encourage and reinforce his behaviors. Patting and high five were also effective but were used less frequently.

Group C

Compared to Group A and B, the student in this group required the most substantial teacher scaffolding to accomplish the task during the computer-assisted instruction. First of all, the student was significantly impaired in cognitive, language, and social development. Secondly, the ERP lessons seemed to be beyond her zone of proximal development. Finally, the student was not motivated by the software and still relied heavily on external reward to keep her engaged with the task.

Simplifying Task to Child's Attainable Level: The matching task in the computer software was initially beyond the ZPD of the student, Kathy. Therefore, the teacher reduced the difficulties of the task to a level that she was able to participate jointly with the teacher (Wood, et al., 1976). In this case, she engaged in the same task (matching) on a more familiar format (picture cards). When she gradually developed the competence to the simplified task, she was challenged to try out the more complex task—the matching task in the computer lesson.

Kathy was able to transfer the understanding from the simplified task to the new task, but in a very restricted way. She was unable to follow the computer direction. The language and vocabulary used in the computer lesson was beyond her understanding. Each time after the material was presented on the screen, the teacher needed to simplify the verbal direction to the level that she could understand (Stone, 2002).

Highlighting Critical Task Features: This type of scaffolding was not observed.

Demonstrating Solution: Kathy was given two chances to respond to each trial. If her first attempt was incorrect, she was asked to try again. When Kathy was unable to respond correctly in two attempts, the teacher would demonstrate the solution by pointing to the correct item or by holding her hand to point to the correct picture.

Maintaining Goal Direction: Because Kathy would be off-task easily, the teacher needed to closely monitor her response to provide immediate intervention. For instance, if Kathy seemed to disengage her attention, the teacher would need to prompt her to attend to the learning task. Sometimes, she would attempt to stand up, walk away, or engage in self-stimulatory behaviors during the instruction. The teacher needed to keep her in pursuit of the learning goals (Wood, et al., 1976).

Controlling Frustration with Mouse Operation: Kathy was unable to functionally operate the computer mouse. In response, a touch screen was used to replace the mouse. The teacher provided training for Kathy to develop proper pointing skills. However, when Kathy point to the item, whether with her fingers or a stylus, her touch was too gentle to be recognized by the device. Therefore, the teacher still needed to control the computer mouse for Kathy to avoid frustration (Wood, et al., 1976).

Promoting Child's Interest: The reinforcement from the computer was ineffective for Kathy. For all the computer sessions, the teacher provided verbal praises and tangible reinforcer to encourage her efforts (Stone, 2002). After each correct response, verbal praise was immediately provided. Additional tangible reinforcer, such as beads, Sprite, and musical toys, was used. Initially, the tangible reinforcer was immediately provided after each correctly completed trial. Gradually, the provision of the tangible reinforcer was extended to every 2 to 3 correct trials.

5. Conclusions

The early literacy skills are fostered by experiences of meaningful interaction with oral and written language through the guidance of adults and older siblings (Sulzby & Teale, 1991). During this developmental period, the literacy-related activities at home and in school play critical roles in facilitating children to discover the print world and to understand the function of literacy (Watson, Layton, Pierce & Abraham, 1994). It was observed that children who manifested milder symptoms of autism, such as Matt and Josh, were more capable of actively participating in the literacy-related activities as their peers without disabilities; children who manifested more severe autistic symptoms, such as Kathy, needed substantial assistance to pay attention to and to participate in these activities. The latter was significantly impacted by the developmental deficits of language and cognitive skills that they did not experience the same broad exposure and deep immersion to literacy events as other children. Therefore, additional direct teaching program is needed to enhance their literacy acquisition (Chall, 1983).

Generally speaking, children without significant delays in cognitive and language development (such as the students in Group A) demonstrated acquisition of early literacy skills equivalent to or, in some areas (e.g., Carl's sight vocabulary), superior to those of typically developing children. In contrast, children who exhibited delays in language but normal cognitive development (such as the students in Group B) demonstrated difficulties with some of the skills (e.g., hearing rhyme/alliteration in words) but were competent to acquire these skills through additional instruction. Finally, children with significant delays in both cognitive and language development (such as Kathy in Group C) were severely impacted in many literacy-related areas (e.g., letter recognition, awareness of print) and thus required substantial intervention to acquire these early literacy skills.

The challenge for the preschool teacher is to design and deliver reading instruction that not only builds on general principles derived from reading research, but also accommodates the myriad individual literacy competencies presented in children with autism. Under the right conditions, computer-assisted instruction can serve as a means of providing effective individualized intervention for children with a wide range of abilities and needs.

5.1 Effective Use of the Computer-Assisted Instruction

In keeping with the contemporary understanding of autism, the children in this study portrayed wide variation associated with this heterogeneous syndrome. Each of them manifested unique abilities and deficits in cognitive, language and communication, social, and motor development. In terms of reading, some of them were already early readers and recognized a number of words; some had acquired a few phonetic rules; still some had not mastered the alphabet. Not surprisingly, the off-the-shelf computer software, Edmark Reading Program (ERP), effectively helped some but not all of the children to acquire sight vocabulary.

The ERP instruction itself is drill-and-practice in nature and is focused on training the student to acquire and master reading sight words. In order to benefit from the instruction, the student should at a minimum possess proficient alphabet recognition skills and sufficient receptive language skills. The former does not refer to perfect identification of all, but to the majority of letters. When a child can recognize most letters with confidence, he/she will have easier time learning to process and remember words without investing extensive amount of effort to identify uncertain letters. The latter indicates the ability to comprehend the language and vocabulary in the software in order to follow the computer directions. As the level of actual development in the zone of proximal development (ZPD), the developmental prerequisites serve the foundation to build up to a higher level of competence. Therefore, as previously illustrated, Kathy, who recognized a few letters and comprehended very limited vocabulary, had great difficulties with the ERP tasks.

On the other hand, this higher level of competence, as the level of potential development in the ZPD, should lead ahead of the actual development for the student to profit from the instruction. More specifically, if the student already recognizes the sight words taught in the ERP, it is questionable that the ERP serve as a good instruction for the student. As Stone (2002) stated, if the tasks are not challenging for the student, it is merely skill training instead of instruction. For example, Carl was not pulled into a ZPD interaction since he already knew the words in question.

All the children in Group A and B were interested in computers. However, Edmark Reading Program was motivating for only one student, Josh, in Group A but all the students in Group B. Such contrast between Group A and B indicated that the design of ERP instruction matched the learning needs of students in Group B—a clear structure for them to follow and salient stimuli to recruit their interests. The followings are the list of features incorporated in the ERP instruction:

- Clear instructional sequence
- Systematic provision of prompting after incorrect response
- Immediate provision of positive reinforcement after correct response
- Eliciting attention with perceptually salient presentation of instructional materials, prompting, and reinforcement
- Reducing confusion through simple and prolonged delivery of instructional materials, prompting, and reinforcement

These pieces together create a structural and motivating learning experience for the four children with autism. However, for most students in Group A and the student in Group C, the instructions provided by the software were not always motivating. For the other three students in Group A, the tasks were probably too repetitive to be a challenging instruction (Stone, 2002). In contrast, these tasks were probably too difficult for the student in Group C.

For six of the eight students, their progress and achievement indicated that ERP was an effective means to deliver reading instruction when supplemented with interactive, learner-responsive teacher scaffolding.

5.2 Critical Teacher Scaffolding during the Computer-Assisted Reading Instruction

Although in a more general level the computer could construct a learning experience appropriate for children with autism, the Edmark Reading Program was unable to offer individualized support in a more specific level these children needed. Yet, the teacher could. Throughout the computer-assisted instruction, the teacher closely assessed the understandings and needs of each child to provide timely and suitable support. The support provided temporary scaffolds allowing the child's competence to be built up until independent performance of the task was achieved. In response to the diverse needs of the children, a wide variety of teacher scaffolding was provided in the following areas:

Simplifying Task to Child's Attainable Level: A good example of this type of scaffolding was illustrated in the training provided for Kathy to develop her competence with the software. Initially, the task in the computer program was beyond her ZPD. The task was simplified to an achievable level for Kathy. With significant teacher guidance, she continued to develop the competence and to participate at an ever-increasing level of competence (Palincsar & Brown, 1984).

Highlighting Critical Task Features: A common mistake that occurred during a more complicated ERP lesson was matching two sets of word with its corresponding picture. While the computer prompted the matching in a fixed sequence, most students would complete the second task first. The teacher would prompt the students to attend to the sequence. After teacher prompting, all the students (in Group A and B) were gradually able to follow the right sequence.

Demonstrating Reading Practices: Through teacher demonstration, students in Group A and B learned to read following the conventional norm, such as reading words from left to right. Some of them also learned to trace words with the finger and self-correct reading errors. With the ongoing monitoring of the student's performance, the teacher could immediately identify discrepancy and modeled the desirable action.

Maintaining Goal Direction: Ken and Kathy were given substantial teacher prompting because of their frequent off-task behavior. The teacher consistently used verbal and gestural prompt to direct the students' attention. Occasionally, the teacher needed to redirect them from engaging in self-stimulatory behavior to the task.

Controlling Frustration with Mouse Operation: All the students in Group B and C experienced difficulties operating the computer mouse. The difficulties they encountered included moving the computer mouse to designated area, corresponding the location of the cursor to the mouse movement, pressing down and lifting up fingers for the clicking motion, and clicking the correct button on the mouse to make selection. The explanation and demonstration of proper mouse use from the teacher greatly reduced the frustration some children initially experienced. While most children in the study gradually became skillful of operating the mouse, Ken and Kathy continued to rely on intensive teacher help with the mouse.

Promoting Child's Interest: Stone (2002) suggested that it was important to encourage children's engagement when providing scaffolded instruction. During the instruction, verbal praise provided by the teacher was important to promote all the children's reading behaviors and some children's interest in using the technology. In general, in the initial stage of skill acquisition (for both reading and technology use), the praise was provided immediately after each correct attempt. Gradually, the provision of the verbal praise was decreased as the child developed increasing competence with the practices.

The effectiveness of the computer-assisted instruction relies on two levels of scaffolding. First, the computer affordance provides beneficial learning experiences for children with autism. Embedded in this computer-assisted instruction includes clear and predictable structure, simple but perceptually salient feature, and systematic provision of stimulus, prompting, and reinforcement. The computer-assisted instruction provides a safe environment for students to participate even though they are not yet fully competent. At a second level, the teacher scaffolding for each student ensures the success of the instruction because it is responsive to students' instructional needs that are idiosyncrative and unknowable to this computer system in question. The individualized support flexibly guides the student toward the development of the competence. In summary, when implementing computer-assisted instruction for children with autism, both the computer and the teacher play critical roles in the success of the instruction. The computer and the teacher should be thought of as complementing each other in order to maximize the benefits of the children.

6. Limitations and Future Directions

This study reveals that most children with autism can make significant progress in learning to read and in gaining sight vocabulary through the computer-assisted instruction accompanied with specific teacher scaffolding. The details have direct implications for coordinating computer-assisted instruction with the development of children with autism. However, this study has a number of limitations. The reading instruction was implemented in a relatively short period of time. Although the immediate results were promising, the long-term effects of this instructional approach were unattainable. Furthermore, only one participant represented children who are severely impacted by not only autism but also accompanying mental retardation (cognitive development two standard deviations below). More participants in this developmental category are needed to provide better understanding of not only their reading competencies and the efficacy of computer-assisted instruction for such children, but also the coherence of this group. Finally, this study only analyzed the effects of one instructional approach, without any direct comparison with another approach.

More in-depth analyses of the early literacy development of children with autism are needed to improve the current reading practices. Longitudinal investigations are also needed, particularly for students with significant cognitive and language delays, to further examine the efficacy of computer-assisted reading instruction with responsive teacher scaffolding. Furthermore, individuals with autism usually show little flexibility applying the acquired skills to different circumstances (Olley & Gutentag, 1999). It is likely that some children with autism will be able to read in the computer-assisted instruction, but fail to read the sign before going into the restroom. Therefore, it is critical to look into the transfer of reading competence to real life situations (Panyan, 1984). This, in return, would allow for better approaches to enhance transfer of reading skills.

Finally, research is needed to examine the development of early reading skills through the phonic approach using this proposed instructional model—computer-assisted instruction with complementary teacher scaffolding (Smith, Simmons & Kameenui, 1998). Some of the children in this study had mastered several phonic rules, whereas some were unaware of any letter-sound correspondence. It would be invaluable to investigate how feasible the CAI is in providing adequate individualized instruction for children with autism at different developmental competencies (e.g., verbal vs. non-verbal).

These issues for future research hold the promise of leading to more effective reading instruction for children with autism. In the meantime, it is important to apply what we have learned to improve the educational practices for these children. Computer-assisted instruction has the potential to create beneficial learning environment because of its capacity to support certain types of learning characteristics associated with autism (Panyan, 1984). However, this study showed that teacher scaffolding is a necessary part of such learning system. The teacher plays a critical role to diagnose the learning problems and intervene in developmentally appropriate ways for each child. Such individualized support bridges the gap between the variability in the students and the uniform instruction hard-coded into the computer software. It is evident that the teacher and the computer complement each other to promote meaningful learning of children with autism.

References

Applebee, A. N. (1983). Instructional scaffolding: Reading and writing as natural language activities. *Language Arts, 60*, 8-15.

Bernard-Optiz, V., Ross, K., & Tuttas, M. L. (1990). Computer assisted instruction for autistic children. *Annals Academy of Medicine, 19*(5), 611-616.

Bernard-Opitz, V., Sriram, N., & Nakhoda-Sapuan, S. (2001). Enhancing social problem solving in children with autism and normal children through computer-assisted instruction. *Journal of Autism and Developmental Disorders, 31*, 377-384.

Bernard-Opitz, V., Sriram, N., & Sapuan, S. (1999). Enhancing vocal imitations in children with autism using the IBM speechviewer. *Autism, 3*, 131-147.

Blischak, D. & Schlosser, R. (2003). Use of technology to support independent spelling by students with autism. *Topics in Language Disorders*, 23, 293-304.

Bosseler, A., & Massaro, D. W. (2003). Development and evaluation of a computer-animated tutor for vocabulary and language learning in children with autism. *Journal of Autism and Developmental Disorders,* 33, 653-672.

Boone, R., & Higgins, K. (1993). Hypermedia basal readers: Three years of school-based research. *Journal of Special Education Technology, 12*, 86-106.

Brown, A. L., & Palincsar, A. S. (1987). Reciprocal teaching of comprehension strategies: A natural history of one program for enhancing learning. In J. D. Day, & Borkowski, J. G. (Eds.), *Intelligence and exceptionality: New directions for theory, assessment, and instructional practices* (pp.81-132). Norwood, NJ: Ablex.

Campbell, J. M. (2003). Efficacy of behavioral interventions for reducing problem behavior in persons with autism: A quantitative synthesis of single-subject research. *Research in Developmental Disabilities, 24*(2), 120-138.

Campbell, M L.& Mechling, L. C. (2009). Small Group Computer-Assisted Instruction with SMART Board Technology: An Investigation of Observational and Incidental Learning of Nontarget Information. *Remedial and Special Education, 30* (1), 47-57.

Cazden, C. B. (1979). Peekaboo as an instructional model: Discourse development at home and at school. In *Papers and reports on child language development* (No. 17). Palo Alto, CA: Stanford University, Department of Linguistics.

Chall, J. S. (1983). *Stages of reading development.* New York: McGraw-Hill.

Charlop-Christy, M. H., & Carpenter, M. H. (2000). Modified incidental teaching sessions: A procedure for parents to increase spontaneous speech of their children with autism. *Journal of Positive Behavior Interventions, 2*(2), 98-112.

Chen, S. H., & Bernard-Opitz, V. (1993). Comparison of personal and computer-assisted instruction for children with autism. *Mental Retardation, 31*(6), 368-376.

Ciesielski, K., Courchesne, E., & Elmasian, R. (1990). Effects of focused, selective attention tasks on event-related potentials in autistic and normal individuals. *Electroencephalography and Clinical Neurophysiology, 7*, 207-220.

Colby, K. M. (1973). The rationale for computer-based treatment of language difficulties in nonspeaking autistic children. *Journal of Autism and Childhood Schizophrenia, 3*(3), 254-260.

Colby, K. M., & Smith, D. C. (1971). Computers in the treatment of nonspeaking autistic children. In J. H. Masserman (Ed.), *Current psychiatric therapies* (pp. 1-17). New York: Grune and Stratton.

Dalton, B., Winburg, N. E., & Morocco, C. C. (1990). “If you could just push a button”: Two fourth grade boys with learning disabilities learn to use a computer spelling checker. *Journal of Special Education Technology, 10*, 177-191.

Englert, C. S., & Mariage, T. V. (1991). Making students partners in the comprehension process: Organizing the reading "POSSE." *Learning Disabilities Quarterly, 14*, 123-138.

Englert, C. S., Tarrant, K. L., Mariage, T. V., & Oxer, T. (1994). Lesson talk as the work of reading groups: The effectiveness of two interventions. *Journal of Learning Disabilities, 27*, 165-185.

Fleer, M. (1992). Identifying teacher-child interaction which scaffolds scientific thinking in young children. *Science Education, 76*(4), 373-392.

Frith, U., & Baron-Cohen, S. (1987). Perception in autistic children. In D. J. Cohen & A. M. Donnellan (Eds.), *Handbook of autism and pervasive developmental disorders*. New York: Wiley.

Fuchs, L. S., Fuchs, D., Hamlet, C. L., Powell, S. R., Capizzi, A. M., & Seethaler, P. M. (2006). The Effects of Computer-Assisted Instruction on Number Combination Skill in At-Risk First Graders. *Journal of Learning Disabilities, 39*(5), 467-475.

Goldsmith, T. & LeBlanc, L. (2004). Use of technology in interventions for children with autism. *The Journal of Early and Intensive Behavioural Intervention*,1(2),166-178.

Goodman, K. S., & Goodman, Y. M. (1979). Learning to read is natural. In L. B. Resnick & P. A. Weaver, *Theory and practice of early reading*, vol1, (pp. 137-154). Hillsdale, NJ: Erlbaum.

Gunn, B. K., Simmons D. C., & Kameenui, E. J. (1998). Emergent literacy: Instructional and curricular basics and implications. In D. C. Simmons & E. J. Kameenui (Eds.), *What reading research tells us about children with diverse learning needs: Bases and basics* (pp. 51-59). Mahwah, NJ: LEA.

Harris, S., Handleman, J., & Burton, J. (1990). The Standford Binet profiles of young children with autism. *Special Services in the School, 6,* 135-143.

Heimann, M., Nelson, K. E., Tjus, T., & Gillberg, C. (1995). Increasing reading and communication skills in children with autism through an interactive multimedia computer program. *Journal of Autism and Developmental Disorders, 25*(5), 459-480.

Hermelin, B., & O'Connor, N. (1970). *Psychological experiments with autistic children.* London: Pergamon.

Hogan, K., & Pressley, M. (1997). Scaffolding scientific competencies within classroom communities of inquiry. In Hogan, K., & Pressley, M. (Eds.), *Scaffolding student learning: Instructional approaches and issues.* Cambridge, MA: Brookline.

Horton, S. V., Lovitt, T. C., Givens, A., & Nelson, R. (1989). Teaching social studies to high school students with academic handicaps in a mainstreamed setting: Effects of a computerized study guide. *Journal of Learning Disabilities, 22*(2), 102-107.

Jerome, A. & Barbetta, P. M. (2005). The Effect of Active Student Responding during Computer-Assisted Instruction on Social Studies Learning by Students with Learning Disabilities. *Journal of Special Education Technology, 20*(3), 13-23.

Jordan. R., & Powell, S. (1990a). Teaching autistic children to think more effectively. *Communication, 24*, 20-23.

Jordan, R., & Powell, S. (1990b). Improving thinking in children with autism using computer presented activities. *Communication, 24*, 23-25.

Kerchner, L. B., & Kistinger, B. J. (1984). Language processing/word processing: Written expression, computers, and learning disabled students. *Learning Disabilities Quarterly, 7*(4), 329-335.

Lovvas, O. I. (2003). *Teaching individuals with developmental delays: Basic intervention techniques.* Austin, TX: Pro-ed.

MacArthur, C. A., & Haynes, J. B. (1995). Student assistant for learning from text (SALT): A hypermedia reading aid. *Journal of Learning Disabilities, 28*(3), 150-159.

McGee, G. G., Morrier, M. J., & Daly, T. (1999). An incidental teaching approach to early intervention for toddlers with autism. *Journal of the Association for Persons with Severe Handicaps, 24*(3), 133-146.

Miranda-Linne, F., & Melin, L. (1992). Acquisition, generalization, and spontaneous use of color adjectives: A comparison of incidental teaching and traditional discrete-trial procedures for children with autism. *Research in Developmental Disabilities, 13*(3), 191-210.

Moore, M., & Calvert, S. (2000). Brief report: Vocabulary acquisition for children with autism: Teacher or computer instruction. *Journal of Autism and Developmental Disorders, 30*(4), 359-362.

Moore, R., & Goldiamond, I. (1964). Errorless establishment of visual discrimination using fading procedures. *Journal of the Experimental Analysis of Behavior, 7*, 269-272.

Olley, J. G., & Gutentag, S. S. (1999). Autism: Historical overview, definition, and characteristics. In D. B. Zager (Ed.), *Autism: Identification, education, and treatment* (pp. 3-22). Mahwah, NJ: LEA.

Panerai, S., Ferrante, L., & Zingale, M. (2002). Benefits of the treatment and education of autistic and communication handicapped children (TEACH) programme as compared with a non-specific approach. *Journal of Intellectual Disability Research, 46*(4), 318-327.

Panyan, M. V. (1984). Computer technology for autistic students. *Journal of Autism and Developmental Disorders, 14*(4), 375-382.

Palincsar, A. S., & Brown, A. L. (1984). Reciprocal teaching of comprehension-fostering and comprehension-monitoring activities. *Cognition and Instruction, 1*, 117-175.

Palincsar, A. S., Winn, J., David, Y., Snyder, B., & Stevens, D. (1993). Approaches to strategic reading instruction reflecting different assumptions regarding teaching and learning. In L. Meltzer (Ed.), *Strategy assessment and instruction for students with learning disabilities: From theory to practice* (pp. 247-270). Austin, TX: Pro-Ed.

Quill, K. A. (1997). Instructional considerations for young children with autism: The rationale for visually cued instruction. *Journal of Autism and Developmental Disorders, 27*(6), 697-714.

Rogoff, B. (1990). *Apprenticeship in thinking: Cognitive development in sociocultural activity.* New York: Oxford University Press.

Rogoff, B., Malkin, C., & Gilbride, K. (1984). Interaction with babies as guidance in development. In B. Rogoff, & J. V. Wertsch (Eds.), *Children's learning in the "Zone of Proximal Development" (pp. 31-44).* San Francisco: Jossey-Bass.

Rosenshine, B., & Meister, C. (1992). The use of scaffolds for teaching higher-level cognitive strategies. *Educational Leadership,49*(7) , 26-33.

Russo, D. C., Koegel, R. L., & Lovaas, O. I. (1978). A comparison of human automated instruction for children with autism. *Journal of Abnormal Child Psychology 6*(2), 189-201.

Salomon, G. (1991). Transcending the qualitative-quantitative debate: *The analytic and systematic approaches to educational research. Educational Researcher, 20*(6), 10-18.

Schopler, E., Mesibov, G. B., & Hearsey, K. (1995). Structured teaching in the TEACH system. In E. Schopler, & G. B. Mesibov (Eds.), *Learning and cognition in autism* (pp. 243-268). New York: Plenum Press.

Shimizu, H., Twyman, J. S., & Yamamoto, J. (2003). Computer-Based Sorting-to-Matching in Identity Matching for Young Children with Developmental Disabilities. *Research in Developmental Disabilities, 24*(3), 183-94.

Skinner, B. F. (1953). *Science and human behavior.* New York: Macmillan.

Sigman, M., Ungerer, J., Mundy, P., & Sherman, T. (1987). Cognition in autistic children. In D. J. Cohen & A. M. Donnellan (Eds.), *Handbook of autism and pervasive developmental disorders.* New York: Wiley.

Silver, M., & Oakes, P. (2001). Evaluation of a new computer intervention to teach people with autism or asperger syndrome to recognize and predict emotions in others. *Autism, 5,* 229-316.

Smith, S. B., Simmons, D. C., & Kameenui, E. J. (1998). Phonological awareness: Research bases. In D. C. Simmons & E. J. Kameenui (Eds.), *What reading research tells us about children with diverse learning needs: Bases and basics* (pp. 61-127). Mahwah, NJ: LEA.

Smith, T. (2001). Discrete trial training in the treatment of autism. *Focus on Autism and Other Developmental Disabilities, 16*(2), 86-92.

Stone, C. A. (2002). Promises and pitfalls of scaffolded instruction for students with learning disabilities. In K. G. Butler & E. R. Silliman (Eds.), *Speaking, reading, and writing in children with language learning disabilities* (pp. 175-198). Mahwah, NJ: LEA.

Sulzby, E., & Teale, W. (1991). Emergent literacy. In R. Barr, M. L. Kamil, P. B. Mosenthal & P. D. Pearson (Eds.), *Handbook of reading research* (Vol. II, pp. 727-757). New York: Longman.

Tjus, T., Heimann, M., & Nelson, K. E. (1998). Gains in literacy through the use of a specially developed multimedia computer strategy. *Autism 2*(2), 139-156.

Twyman, T. & Tindal, G. (2006). Using a Computer-Adapted, Conceptually Based History Text to Increase Comprehension and Problem-Solving Skills of Students with Disabilities. *Journal of Special Education Technology, 21*(2), 5-16.

Vedora, J. & Stromer, R. (2007). Computer-Based Spelling Instruction for Students with Developmental Disabilities. *Research in Developmental Disabilities: A Multidisciplinary Journal, 28*(5), 489-505.

Watson, L. R., Layton, T. L., Pierce, P. L., & Abraham, L. M. (1994). Enhancing emergent literacy in a language preschool. *Language, Speech, and Hearing Services in Schools, 25*, 136-145.

Wertsch, J. V., & Rogoff, B. (1984). Editors' notes. In B. Rogoff, & J. V. Wertsch (Eds.), *Children's learning in the "Zone of Proximal Development"* (pp. 1-6). San Francisco: Jossey-Bass.

Whitehurst, G. J., Falco, F., Lonigan, C. J., Fischal, J. E., DeBaryshe, B. D., Valdez-Manchaca, M. C., & Caulfield, M. (1988). Accelerating language development through picturebook reading. *Journal of Developmental Psychology, 24*, 552-559

Williams, C., Wright, B., Callaghan, G., & Coughlan, B. (2002). Do children with autism learn to read more readily by computer assisted instruction or traditional book methods? *Autism, 6*(1), 71-91.

Wood, D. (1980). Teaching the young child: Some relationships between social interaction, language, and thoughts. In R. Olson (Ed.), *The social foundations of language and thought* (pp. 280-296). New York: Norton.

Wood, D., Bruner, J. S., & Ross, G. (1976). The role of tutoring in problem solving. *Journal of Child Psychiatry and Psychology, 17*, 89-100.

Zager, D. B., Shamow, N. A., & Schneider, H. C. (1999). Teaching students with autism. In Zager, D. B. (Ed.), *Autism: Identification, education, and treatment* (pp. 111-139). Mahwah, NJ: LEA.

電腦輔助教學中教師對自閉症學童的鷹架式引導

黃正芳

本研究的目的在探究如何使電腦輔助教學軟體對自閉症學童的閱讀學習發揮最大效益。透過對 8 位學齡前自閉症兒童(包含輕度至重度)的個案研究，及對他們使用學習常見字彙(sight vocabulary)的電腦輔助教學軟體的觀察紀錄，發現輕度至中度自閉症兒童能透過該軟體有效學習閱讀。該電腦輔助教學軟體提供在感知上清楚的刺激、有系統的提示與增強、簡單而可預測的架構，符合自閉症兒童的學習特性；另一方面，由於每位自閉症兒童認知能力、語言理解與表達、人際關係、固著行為等障礙的個別差異，在學習過程中，教師針對各學童特質而提供的暫時性鷹架(scaffolding)，則能適切引導學童，彌補電腦教學軟體個別化的不足。本研究參考 Wood, Bruner, and Ross (1976)所提出的鷹架，分析教師在電腦輔助教學過程所提供的鷹架功能如下：(1)簡化學習活動至學生可達成的目標，(2)指出學習活動的關鍵特徵，(3)示範正確作答方式或示範閱讀，(4)維持學習的目標，(5)減少使用滑鼠的挫折，(6)提昇對學習活動的興趣。研究結果指出教師提供暫時性的鷹架(scaffolding)配合電腦輔助教學軟體的學習，能有效幫助輕度至中度自閉症學童的字彙閱讀。

關鍵字：電腦輔助教學；鷹架；自閉症；字彙學習

作者現職：銘傳大學應用語文學院英語教學組助理教授

通訊作者：黃正芳，e-mail: rebecca@mail.mcu.edu.tw