The Efficacy of Computer Assisted Instruction for Advancing Literacy Skills in Kindergarten Children

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Abstract

In this study we examined the benefits of computer assisted instruction (CAI) used to supplement a phonics-based reading curriculum for kindergartners in an urban public school system. The CAI program provides systematic exercises in phonological awareness and simple sound/symbol correspondences. Comparisons were made between children in classes receiving CAI and children in matched, control classes taught by the same teacher but without CAI support. Students were included in the treatment group if they used the CAI program for a sufficient, prescribed amount of time (approximately 16 hours over six months). The treatment and control groups did not differ on pretest measures of preliteracy skills. There were, however, significant differences between groups on post-test measures of reading skills. The greatest post-test differences were found when analyses were restricted to students with the lowest pretest scores.

According to *The Nation's Report Card: Reading 2002* (Grigg, Daane, Jin, & Campbell, 2003), more than 50% of students in the United States today score below grade level on tests of reading (Sweet, 2004). To address this "literacy crisis," it has been strongly recommended in the National Reading Council report, *Preventing Reading Difficulties in Young Children* (Snow, Burns, & Griffin, 1998), that early reading instruction should be geared to the development of phonic word-attack strategies. A key component in building phonics skills is phonological awareness (Adams, 1990; Liberman & Shankweiler, 1985; Share & Stanovich, 1995; Wagner & Torgesen, 1987). Phonological awareness requires the ability to analyze the sound structure of spoken language. In particular, it includes the ability to segment words into syllables and smaller sound units, as well as to blend these units back into words. Facility in processing sound units in spoken language provides a foundation for mastery of sound-symbol correspondence rules employed in identifying words in print. In many instances, typically developing children will readily acquire both phonological awareness and phonics skills in the context of regular classroom instruction; however, in the case of young struggling readers, a more intense effort to build these skills is necessary to prevent further decline at later ages (Torgesen, 2004).

A number of researchers have investigated the efficacy of training phonological awareness on acquisition of literacy skills in children (for meta-analyses, see Bus & van Ijzendoorn, 1999; Ehri, Nunes, Willows, Schuster, Yaghoub-Zadeh, & Shanahan, 2001). According to the *Report of the National Reading Panel* (National Institute of Child Health and Human Development [NICHD], 2000), training in phonological awareness can provide benefits in the acquisition of early literacy skills. For example, in a study with kindergartners Torgesen, Morgan, and Davis (1992) divided their participants into three groups – one received practice in sound blending, a second received practice in sound segmenting and blending, and a third received no explicit phonological training. Improvements in the targeted phonological awareness skills were found in both training

groups; in addition, participants in the segmenting and blending group were able to learn a novel set of words at a faster rate than children in the other groups (see also Brady, Fowler, & Stone, 1994; Lundberg, Frost, & Petersen, 1988).

From their meta-analysis, Bus and van Ijzendoorn (1999) concluded that phonological awareness training is particularly beneficial for young readers when it is combined with instruction in phonic word-attack strategies. For instance, Ball and Blachman (1991) provided instruction in phonological awareness (segmenting words into phonemes) and simple phonics (basic sound-symbol correspondences) to a group of kindergartners. After instruction, these children performed significantly higher on a word reading test than kindergartners who worked on general language activities and phonics (without phonological awareness). Similar findings were obtained in a recent large-scale study with kindergartners (and pre-kindergartners) conducted by Hatcher, Hulme, and Snowling (2004). They reported significant benefits in reading words and nonwords following classroom instruction in phoneme manipulation and phonics. Children receiving phoneme manipulation plus phonics outperformed children receiving phonics alone. Hatcher et al. (2004) noted, however, that the benefits of phonics plus phoneme manipulation occurred for low-performing children only. Average to above-average performers showed strong benefits from phonics alone.

A number of researchers have studied the benefits of computer assisted instruction (CAI) to support reading development in low performing children (for review, see MacArthur, Ferretti, Okolo & Cavalier, 2001). In general, CAI is well suited as a supplementary aid to direct reading instruction. Computers are capable of presenting activities that are interesting and motivational to children – including the use of pictorial displays and positive feedback. Children can work at their own pace and receive enough practice to support word recognition skills and eventually fluent text reading.

Many of the CAI programs have targeted phonological awareness skills. Two of the programs are *Daisy Quest* and *Daisy's Castle* (Foster, Erickson, Forster, Brinkman, & Torgesen, 1994). These programs provide activities in sound identification and segmentation of words into sounds. Foster et al. reported that preschoolers and kindergartners receiving CAI showed significant gains in phonological awareness skills compared to children not receiving CAI support. In a subsequent study Torgesen and Barker (1995) found that practice with *Daisy Quest* and *Daisy's Castle* lead to significant improvements in phonological awareness and word reading skills in first graders identified as lagging behind their peers in decoding abilities. More recently, Mitchell and Fox (2001) reported significant and comparable gains on phonological processing tasks in two groups of low performing kindergartners and first graders, one group received teacher-delivered phonological awareness training and the second group used *Daisy Quest* and *Daisy's Castle*. Similar benefits of CAI as a tool for learning phonological awareness and sound/symbol correspondences in support of reading instruction have been found for Dutch-speaking kindergartners (Reitsma & Wesseling, 1998; van Daal & Reitsma, 2000) and for children learning to read Hebrew (Mioduser, Tur-Kaspa, & Leitner, 2000).

In a comprehensive study involving 200 students in grades 2 through 5 identified as poor readers, Wise, Ring and Olson (2000) contrasted two CAI programs for enhancing reading skills -- "phonological-analysis," which included practice identifying sounds in nonwords and manipulating sound/letter patterns, and "accurate-reading-in-context," which mainly focused on learning strategies for reading comprehension. Overall, Wise et al. found that "phonological-analysis" provided greater benefits in phonological awareness skills and untimed word reading than "accurate-reading-in-context," particularly for children who had the lowest initial reading levels.

Although most published studies report benefits of CAI for reading acquisition, a recent study by Paterson, Henry, O'Quin, Ceprano, and Blue (2003) failed to find support for CAI. Paterson et al. investigated the effectiveness of the Waterford Early Reading Program, Level 1 (WERP-1) in kindergarten classrooms from an urban public school system. WERP-1 provides practice in rhyming, sound segmenting and blending, alphabet skills, and concepts of print. Using data from an observational survey of early literacy skills, Paterson et al. reported no differences between children in classrooms receiving WERP-1 and children in control classes without WERP-1. Instead, teacher variables such as "literacy facilitation" and "instructional time" were associated with differences in classroom performance (see also Weiner, 1994). In a related study, however, Hecht and Close (2002) compared kindergartners in classrooms receiving WERP-1 with kindergartners from classrooms without CAI. In contrast to Paterson et al. (2003), Hecht and Close found significantly higher post-test scores on tests of phonological awareness and word reading for kindergartners in the WERP-1 classrooms. Hecht and Close also noted wide variations among children in amount of time using the WERP-1 software, and a main predictor of post-test scores was "time using the WERP-1."

For this research project, we extended a recently completed study examining the benefits of two CAI programs *Phonics Based Reading* and *Strategies for Older Students* (Lexia Learning Systems, 2001) designed to supplement reading instruction in first graders (Macaruso, Hook, & McCabe, in press). The programs provide systematic exercises for mastering word-attack strategies. We found that children both in classrooms receiving CAI and in control classrooms benefited from receiving regular phonics-based reading instruction as part of their daily curriculum. However, when analyses were restricted to "at risk," low performing children, significantly higher gains in reading were found for children receiving CAI compared to children in control classrooms.

In this report, we discuss findings from an intervention study in which CAI in phonological awareness and early phonics skills was provided to kindergarten children. The CAI program called *Early Reading* (Lexia Learning Systems, 2003) is designed to supplement classroom instruction in building a foundation for emerging literacy skills. *Early Reading* contains a variety of activities involving sound identification, rhyming, segmenting and blending of sounds, and application of sound/symbol correspondences for subsets of consonants and vowels. The activities make use of visual graphics, are highly interactive, and are followed by immediate feedback. The activities branch automatically based on the student's individual performance, reviewing when necessary and moving to more advanced items when easier ones have been mastered.

We had an opportunity to evaluate *Early Reading* under conditions in which classroom, teacher, and instruction variables were held constant. Comparisons were made between classes receiving CAI and control classes taught by the same teacher in the same classroom but without CAI support. Most studies that attempt to assess the benefits of CAI to supplement reading instruction do not include adequate controls for teacher and classroom variables, and these variables are known to have a significant impact on the academic performance of young children (e.g., Paterson et al., 2003; see Troia, 1999). The present study allowed us to assess the effectiveness of CAI in the context of matched classes. A second purpose of this study was to address directly the benefits of CAI for kindergartners identified as low performers. There has been evidence indicating that CAI can be particularly effective for children at risk for learning problems (see MacArthur et al., 2001; Macaruso et al, 2005; Mitchell & Fox, 2001; Wise et al., 2000). A final goal of the study was to investigate the effects of program use on reading performance within the treatment classes. Children who made sufficient use of CAI were analyzed separately from those who did not (see Hecht & Close, 2002).

METHOD

Participants: Six kindergarten classes were selected for participation in this experiment. The classes were located in two urban elementary schools in a greater Boston school district. The six classes consisted of a morning class and an afternoon class taught by three teachers. One class for each teacher was randomly assigned to treatment and the other class for that teacher was considered a control class. One morning class and two afternoon classes were treatment classes, and two morning classes and one afternoon class were control classes. There were 47 students (23 male, 24 female) in treatment classes and 47 students (22 male, 25 female) in control classes. The mean age of students in treatment classes was 67 months (sd = 3.9), and the mean age for students in control classes was 66 months (sd = 3.7). The students came from diverse socio-cultural backgrounds. Approximately 20% of the families in the school district were foreign born, and 29% of the students in the sample spoke a language other than English at home. Economic data reflect the city's relative lack of prosperity. The median household income of $37,000 was well below the median level in Massachusetts (approximately $50,000).

The treatment classes contained six students classified as ESL and three students eligible for special education (SPED) services. There were no ESL students and two SPED students in the control classes. Given the uneven number of ESL/SPED students in the two groups, these students were excluded from the sample. The reduced sample consisted of 38 students (19 male, 19 female) in treatment classes and 45 students (20 male, 25 female) in control classes.

The treatment classes began using Lexia software in November, 2003 and continued for approximately six months. The software is designed for regular weekly use (two to four weekly sessions of 15-20 minutes each). The software tracks sessions completed for each

student. The mean number of sessions completed was 48, with a range of 30 - 62 sessions. Students took part in varying numbers of sessions mainly due to absences and scheduling discrepancies across classes. Given evidence that sufficient use of CAI is needed to support gains in literacy (e.g., Hecht & Close, 2002), we set as a minimum criterion 45 sessions completed (i.e., approximately two sessions per week) for a student to be included in the treatment group. There were 26 students (out of 38 non-ESL/SPED students in the treatment classes) who met the criterion and were placed in the final treatment group. These students (12 males, 14 females) averaged 52 sessions completed. All analyses involving the treatment group included these 26 students only. The remaining 12 students who did not meet the criterion are referred to as "low users." The low users averaged 38 sessions.

Materials and Procedures: All treatment and control classes were engaged in daily reading instruction using some form of explicit phonics instruction based on *Scott Foresman Reading* (McFall, 2000) and/or *Bradley Reading and Language Arts* (Bradley, 1999). *Scott Foresman Reading* is a comprehensive reading program that includes activities in oral vocabulary, phonemic awareness, letter-sound recognition, and story comprehension. It contains teaching resources, assessment handbooks, student storybooks, writing materials and manipulatives. *Bradley Reading and Language Arts* is a multi-sensory, systematic phonics program. Each teacher reported following the same scope and sequence of reading instruction for her treatment and control classes.

The *Early Reading* program was installed on the networks in each school building and mapped to individual classroom and laboratory stations. Nearly all of the program use occurred in computer laboratories. The kindergarten teachers and laboratory staff members took part in orientation and training sessions for software implementation. *Early Reading* has two levels. Level 1 contains 4 skill activities and 56 discrete units. The

activities in Level 1 are designed to enhance phonological awareness skills, including recognition of initial and final sounds in words, rhyming words, segmenting words into syllables and sounds, and blending syllables and sounds into words. Level 2 contains 5 skill activities and 60 discrete units. Level 2 activities reinforce recognition of initial and final sounds and introduce sound/symbol correspondences for consonants, vowels and consonant digraphs. Both levels make use of matching tasks with auditory/visual stimuli (e.g., matching the sound /b/ or the letter *b* with a pictured object beginning with that sound or letter, such as *book*). The activities are highly structured and systematic, building from basic to more advanced skills. Each student was initially placed in Level 1 and then worked independently through the activities. During the time when students in the treatment classes were participating in the Lexia programs, students in the control classes were receiving regular classroom instruction.

The software program records skill units completed for each student. The mean number of skill units completed by the 26 students in the treatment group was 66 (range: 30 - 116). Sixteen of these students worked exclusively on Level 1 activities and 10 advanced to Level 2 activities.

Two subtests from the *Dynamic Indicators of Basic Early Literacy Skills, 6th Edition* (*DIBELS)* (Good & Kaminski, 2003) were administered by the school district at the beginning of the school year (September, 2003). The subtests were *Initial Sound Fluency* (ISF) and *Letter Naming Fluency* (LNF). The ISF subtest requires the student to look at a set of four pictures and either point to the picture that begins with a sound produced by the tester or say the initial sound of an orally presented word that matches one of the pictures. Scoring is based on the number of initial sounds identified or produced correctly in one minute. For the LNF subtest, the student is asked to name aloud as many letters as possible in one minute. The letters are presented randomly in rows of ten, with uppercase and lowercase

letters mixed in each row. Raw scores on the *DIBELS* subtests served as pretest measures of early literacy skills. The *Gates-MacGinitie Reading Test, Level PR* (W. MacGinitie, R. MacGinitie, Maria, & Dreyer, 2000) was administered at the end of the school year (June, 2004) and served as a post-test assessment of literacy-related skills. Level PR contains four subtests – oral language concepts (phonological awareness), letters and letter-sound correspondences, literacy concepts, and listening (story) comprehension. Dependent measures included raw scores for each subtest and a normal curve equivalent (NCE) score based on the total raw score. (Note: NCE scores are on a 100 point scale with a mean of 50 and a standard deviation of 21.1.)

RESULTS

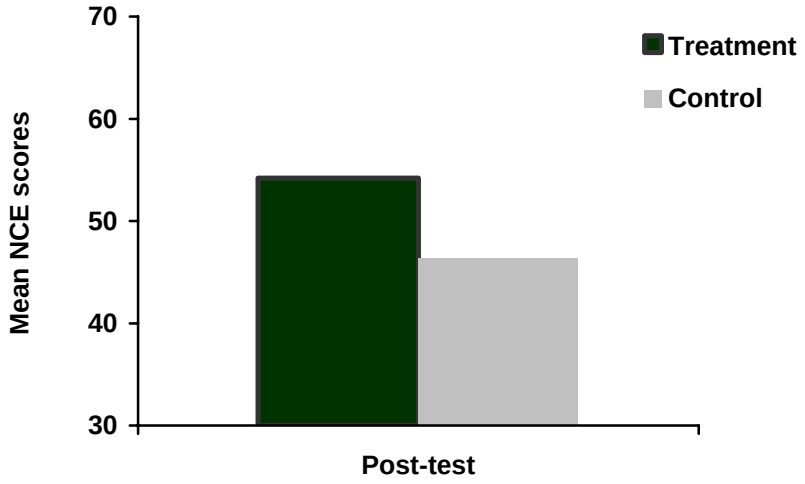
Overall findings. Table 1 presents mean pretest raw scores on the two *DIBELS* subtests for students in the treatment and control groups. There were no significant differences between groups on pretest scores: ISF ($t(69) = 1.13$, $p = .26$) and LNF ($t(69) = 0.63$, $p = .53$). However, an analysis of covariance comparing post-test NCE scores on the *Gates-MacGinitie Reading Test* with both *DIBELS* pretest scores as covariates revealed a significant group difference, $F(1,67) = 4.80$, $p = .03$. The mean NCE score was significantly higher for the treatment group (54.2, sd = 18.0) than the control group (46.4, sd = 14.3). (See Figure 1.)

Table 1. Mean pretest raw scores on the *DIBELS* for all students in the treatment and control groups and for low performers in the two groups.

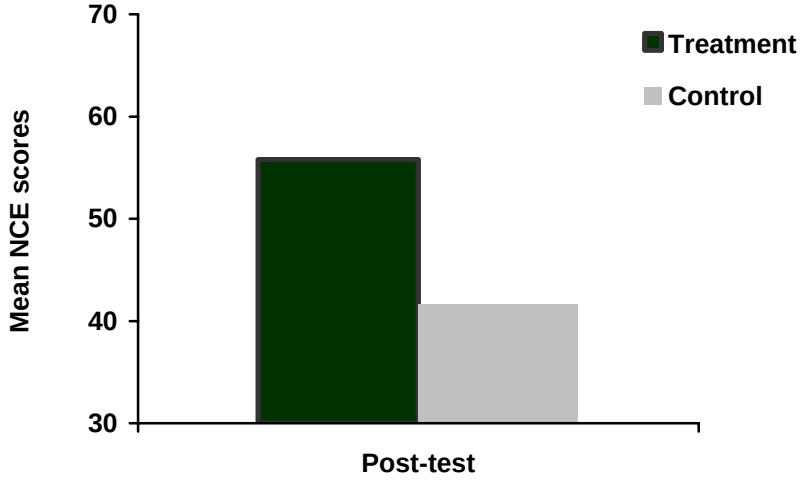
	All students			
	Treatment (N=26)		Control (N=45)	
	Mean	SD	Mean	SD
Initial Sound Fluency	7.1	5.1	8.9	7.1
Letter Naming Fluency	14.2	14.0	12.0	13.5
	Low performers			
	Treatment (N=12)		Control (N=12)	
	Mean	SD	Mean	SD
Initial Sound Fluency	3.1	2.8	2.3	3.3
Letter Naming Fluency	12.2	11.5	10.8	10.4

FIGURE 1. Mean NCE post-test scores on the *Gates-MacGinitie Reading Test* for: a) all children in the treatment and control groups, and b) low performers in the treatment and control groups.

a)



b)



A second set of analyses was conducted to compare groups on post-test raw scores for the four subtests of the *Gates-MacGinitie* (see Table 2). Using both *DIBELS* pretest scores as covariates, a significant difference between groups was found on the oral language concepts (phonological awareness) subtest, $F(1,67) = 4.78$, $p = .03$. The mean score was significantly higher for the treatment group (14.8) than the control group (12.8). Mean scores for the treatment group were uniformly higher than for the control group on the remaining subtests (literacy concepts, letters and letter-sound correspondences, listening comprehension), however group differences were not significant ($p > .15$ for all tests).

Table 2. Mean post-test raw scores on the four subtests of the *Gates-MacGinitie Reading Test* for all students.

	Treatment (N=26)		Control (N=45)	
	Mean	SD	Mean	SD
Oral Language Concepts (20 items)	14.8	4.0	12.8	3.5
Letters and Letter-Sound Correspondences (30 items)	24.7	4.5	23.7	5.4
Literacy Concepts (20 items)	16.8	2.8	15.7	3.0
Listening Comprehension (20 items)	13.6	3.8	12.6	3.5

Low performers. To determine if *Early Reading* might be particularly beneficial for low-performing students, a sub-analysis was conducted with students in the two groups who produced the lowest scores on the *DIBELS* ISF pretest (i.e., the bottom four scorers in each of the three treatment classes and the bottom four scorers in each of the three control classes). These students were selected because they showed signs of weak phonological awareness skills and thus could benefit greatly from participating in *Early Reading.* Table 1 includes mean pretest DIBELS scores for the two groups of low performers. Group differences on pretest scores were not significant (ISF, $t(22) = 0.60$, $p = .55$; LNF, $t(22) = 0.30$, $p = .77$). Using the pretest scores as covariates, the groups showed a significant difference at post-test on overall *Gates-MacGinitie* NCE scores, $F(1,20) = 11.00$, $p < .01$. The mean NCE score was significantly higher for the treatment group (55.8, sd = 12.3) compared to the control group (41.6, sd = 5.9). (See Figure 1). An examination of individual students' scores revealed that 8 of the 12 low performers in the treatment group obtained a post-test NCE score above average (50) compared to only 1 of the 12 low performers in the control group.

Table 3 presents mean post-test raw scores for low performers in the two groups on the four subtests of the *Gates-MacGinitie Reading Test*. Analysis of covariance shows that the treatment group significantly outperformed the control group on the oral language concepts (phonological awareness) subtest ($F(1,20) = 7.95$, $p = .01$). Although the treatment group produced higher scores on the remaining subtests, the group differences failed to reach significance ($.10 < p < .25$ for these tests).

Table 3. Mean post-test raw scores on the four subtests of the *Gates-MacGinitie Reading Test* for low performers.

	Treatment (N=12)		Control (N=12)	
	Mean	SD	Mean	SD
Oral Language Concepts (20 items)	16.0	2.2	12.4	3.6
Letters and Letter-Sound Correspondences (30 items)	25.6	2.6	22.3	5.4
Literacy Concepts (20 items)	17.1	2.5	15.3	2.9
Listening Comprehension (20 items)	13.4	4.1	11.5	3.6

As these analyses show, the pattern of results for low performers mirrored the pattern seen for the entire sample. However, it should be noted that differences favoring the treatment group were greater for low performers than for the entire sample. Effect sizes for the entire sample were in the moderate range (.48 for NCE scores, .53 for oral language concepts), whereas effect sizes for low performers were quite strong (1.56 for NCE scores, 1.24 for oral language concepts).

High and low users. Our final analysis compared students in the treatment group with students excluded from the treatment group because they showed limited use patterns (12 low users). For this analysis we referred to students in the treatment group as "high users." Table 4 presents mean pretest scores on the *DIBELS* and mean post-test NCE

scores on the *Gates-MacGinitie* for high and low users. High users did not differ significantly from low users on pretest scores (ISF, $t(36) = 0.18$, $p = .86$; LNF, $t(36) = 0.65$, $p = .52$); however, an analysis of covariance showed that the high users (54.2) significantly outperformed low users (40.6) at post-test, $F(1,34) = 5.18$, $p = .03$.

Table 4. Mean pretest raw scores on the *DIBELS* and mean NCE scores on the *Gates-MacGinitie Reading Test* for high and low users.

	High users (N=26)		Low users (N=12)	
Pretest *DIBELS*				
	Mean	SD	Mean	SD
Initial Sound Fluency	7.1	5.1	6.8	5.2
Letter Naming Fluency	14.2	14.0	11.1	12.8
Post-test *Gates-MacGinitie*				
NCE Score	54.2	18.0	40.6	16.3

DISCUSSION

This study examined the benefits of a CAI program designed to supplement regular classroom instruction in an urban public school system. The program provides systematic

and structured exercises for developing phonological awareness and basic sound/symbol correspondences in kindergarten children. Comparisons were made between treatment classes receiving the supplemental CAI program and control classes receiving the same phonics-based reading curriculum without CAI support. There were no differences between treatment and control groups on pretest measures of pre-literacy skills. However, at post-test the treatment group significantly outperformed the control group on the *Gates-MacGinitie Reading Test.* The greatest discrepancy between groups at post-test occurred for children with the lowest pretest scores. A closer look at post-test performance on the *Gates-MacGinitie* revealed that the largest difference between groups was on the subtest measuring phonological awareness (oral language concepts). This subtest requires children to identify pictures with names that begin or end with the same sound or pictures that have rhyming names. Higher scores for the treatment group on this subtest indicate that the lowest performers benefited from a more intensive, systematic emphasis on developing phonological awareness through the CAI program. It has been well established that phonological awareness is a key prerequisite for later reading advancement (e.g., Adams, 1990; Share & Stanovich, 1995).

The kindergarten classes available for this study provided an exceptional opportunity to investigate the benefits of an intervention program in closely matched treatment and control settings. Paired morning and afternoon classes were taught by the same teacher using the same curriculum. Each teacher reported following the same daily routine for her two classes. The only difference was that while treatment classes went to computer laboratory, control classes spent extra time engaged in language-related classroom activities. This type of design eliminates many potential threats to internal validity related to teacher and classroom variables which are often seen in field studies assessing the effectiveness of supplementary reading programs (see Troia, 1999). The use of matched classes provides assurance that significant group differences are due to the use of CAI in

the treatment classes, and not to other potential confounding variables that may have been discrepant across groups.

In this study we drew a distinction between children included in the treatment group because they showed sufficient use patterns (i.e., at least 45 sessions or approximately 16 hours over six months) and children excluded from the treatment group because they were low users. Others have reported a relationship between amount of CAI time and reading gains (e.g., Hecht & Close, 2002). Concerns about time on task as it relates to reading gains have also been discussed with regard to non-CAI treatment studies (Ehri et al., 2002), particularly as it applies to low performers (Torgesen, Wagner, & Rashotte, 1997). Here, we found a clear difference in post-test scores between children identified as high users and those who were low users. This result shows that any benefits of CAI on acquisition of reading skills require a sufficient amount of computer time.

The public school system we studied employed highly systematic, phonics-based reading instruction as part of its general curriculum. This conforms to the *Report of the National Reading Panel's* (NICHD, 2000) recommendation that early (and struggling) readers benefit from a systematic, explicit approach to reading instruction. Provided with this curriculum, all classes produced mean reading scores within the average range by the end of the school year, reflecting adequate progress in a low-SES urban school system. We found, however, that participation in the supplementary CAI programs provided an additional boost that differentiated the post-test scores of low performers in the treatment group from low performers in the control group. This finding highlights the fact that well-structured CAI programs can deliver the kind of intensive practice required for low performers to enhance their reading skills (see Wise et al., 2000). However, not all studies have reported benefits of CAI over and above solid reading instruction (e.g., Paterson et al, 2003). Further research is necessary to tease apart the various factors (student

characteristics, type of reading curriculum, teacher variables, CAI activities, intensity of CAI use, etc.) that contribute to whether CAI is likely to provide additional support for children acquiring reading skills.

It should be noted that participation in CAI may be beneficial not only for struggling readers but also for typically developing children. CAI provides an engaging format for all children to practice skills and progress independently at their own rate. In conjunction with CAI programs designed for first graders (see Macaruso et al., in press), typically developing kindergartners could advance beyond *Early Reading* and systematically build skills through higher levels. We are currently conducting research to examine this possibility. In addition, utilizing CAI with typically developing children as part of flexible groupings and center activities would allow teachers to spend extra time with children who may need more individualized support.

In conclusion, the public school system we studied has embraced the use of CAI as part of its regular reading curriculum. Therefore, we had an opportunity to investigate the efficacy of CAI as an integrated component of typical classroom activities – giving rise to a high level of ecological validity (see also Hecht & Close, 2002; Paterson et al., 2003). It should be kept in mind, however, that by studying the benefits of CAI in the midst of typical classroom practice, we sacrificed some degree of control over implementation. Daily alterations to classroom schedules (field trips, assemblies, etc.) inevitably affected weekly CAI use patterns. Nonetheless, we were able to demonstrate benefits of CAI for kindergartners in the early stages of reading acquisition, particularly those who started out as low performers and maintained sufficient use of the program.

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Adelaide Walker is a research associate at Lexia Learning Systems, Inc. She is involved in data management and conducts analyses for Lexia's research studies. She is also a student in the Harvard Graduate School of Education – Program in Human Development and Psychology.

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