Using Innovative Technology to Foster Reading Development Among Young Children with Severe Cognitive Impairments

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Abstract

Using an innovative technology-enhanced program in my classroom, K-1 students with severe cognitive impairments made notable gains in foundational early literacy skills, demonstrated enhanced motivation and independence in learning, and engaged in fewer negative behaviors. In the first year of my using the program, students gained 45% in uppercase letter name knowledge, gained 52% in lowercase letter name knowledge, and doubled their letter sound knowledge. These trends were repeated as I used the program for a second year among a different cohort of students. I found this program to provide the consistent repetition and skill practice my students need while making learning fun and rewarding.

Keywords

technology, reading, autism, literacy

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Teaching young children with severe impairments is as much about divining as teaching, as much about creating as implementing, and all about sleuthing. Every day in the classroom I must deduce what each of my students needs, what tools are available to meet those needs, and how best to use those tools to move past barriers and enable these children to learn basic literacy skills. For while the skills required for my students to learn to read are the same as those required for any emergent reader, the instructional supports my students need can vary dramatically.

Computer technology is becoming increasingly useful not only in providing instruction and discrete practice opportunities, but also in supporting students as they attempt to read.

Emergent readers—whether disabled or not—must master certain foundational literacy skills to become efficient readers (Hurwitz & Abegg, 1999; McKenna, 1998), and research has demonstrated that students who fail to master these skills by the end of first grade are unlikely to catch up with their more literate peers without intensive intervention (Juel, 1988). Scientific research has also identified those reading skills—such as phonemic awareness, fluent letter recognition, and knowledge and application of the alphabetic principle—that are crucial in helping young children learn how to read (National Institute of Child Health and Human Development, 2000).

Phonological processing ability—the ability to identify and manipulate individual sounds within words—is widely accepted as a cornerstone in early reading acquisition. Tasks such as rhyming, phoneme segmentation, and phoneme blending that tap into phonological awareness have repeatedly been shown to predict the efficiency of reading acquisition (Bradley & Bryant, 1983; Gough & Tunmer, 1986) even more strongly than standard measures of intelligence (Stanovich, 2000).

Letter recognition and facility with the alphabetic principle have also been identified as important foundational skills in early literacy development, with solid letter-sound knowledge a prerequisite for acquiring the alphabetic principle: the awareness that letters in print represent sounds in spoken language (Foulin, 2005). Furthermore, research has shown letter name knowledge to be the best individual predictor of kindergarten reading achievement and the second-best predictor of first-grade reading achievement, second only to a measure of phonological processing (Bulat, 2005b; Share, Jorm, Maclean, & Matthews, 1984).

For students with severe cognitive impairments, however, the mastery of such skills requires explicit instruction, substantial repetition, the use of diverse and multisensory instructional techniques (Churchill, Durdel, & Kenney, 1998; Simmons & Kameenui, 1998), and the scaffolding of a child's reading efforts through timely, corrective feedback (Pany & McCoy, 1988).

While teachers, para-professionals, and peer tutors remain a primary source of this type of scaffolded instruction, computer technology is becoming increasingly useful not only in providing instruction and discrete practice opportunities, but also in supporting students as they attempt to read connected text. As computer technology has evolved and become more accessible over the past decades, its potential for supporting reading in-

struction has generated much interest and support in the scientific community (Bryant, Bryant, & Raskind, 1998; Raskind, Gerber, Goldberg, Higgins, & Herman, 1998). Capable of providing large amounts of extended and independent practice requiring minimal teacher supervision, monitoring student progress, and providing unobtrusive and student-controlled corrective feedback, computer-based technologies seem particularly well suited for training in early literacy skills (Reinking & Bridwell-Bowles, 1996). This type of electronic scaffolding "make[s] possible a form of cognitive apprenticeship by permitting children to engage in a complex, authentic, and situated activity (reading) in which the support available to the child eventually fades" (McKenna, 1998, p. 47). McKenna further suggests that "by scaffolding the beginning reader at all times…the decoding and fluency stages might progress virtually in parallel rather than in sequence, with the ultimate effect of accelerating the development of reading ability and enabling fluency to be attained at an earlier age" (p. 51).

Technology's Impact on Instruction

As computer technology has evolved and become more accessible over the past several decades, its potential for assisting in reading instruction has generated much interest and support in the scientific community. Technology is uniquely useful in:

- Providing large amounts of extended and independent practice (Reinking & Bridwell-Bowles, 1996),
- Monitoring student progress to inform truly individualized instruction (Hurwitz & Abegg, 1999),
- Providing unobtrusive and student-controlled corrective feedback (Olofsson, 1992),
- Engaging students for extended periods of time (Reitsma & Wesseling, 1998), and

Reporting on student progress for teacher, administrator, and parent use (Sonak, Suen, Zappe, & Hunter, 2002)

Research demonstrates another benefit of computer-based instruction and intervention: students' increased attention and motivation (Reinking & Bridwell-Bowles, 1996). According to Stanovich (1986), extended involvement in reading is essential for developing reading ability. Supports available in technology-based tools provide this extended access, thus promoting proficiency and fluency. Daiute (1983) and others have found that students exhibit a higher level of motivational engagement when using technological tools. Furthermore, research suggests that using technology-enhanced materials encourages children to work cooperatively, which promotes academic achievement, social interaction, and positive attitudes in the classroom (Baker, 2000). Finally, technology-based programs facilitate the use of regular formative assessments that provide essential informa-

tion to educators in the planning and delivery of instruction and thus serve as an early warning system to monitor the progress of students toward grade-level targets (Black, 1998).

MY STORY: 2005 IMPLEMENTATION

During the spring of the 2004-5 academic year, I was introduced to an innovative technology-based literacy program and agreed to test its effectiveness among my K-1 students with severe cognitive impairments. This program, The Literacy Center curriculum by LeapFrog SchoolHouse®,[1] uses the power of computer technology to support students, embedding technology in engaging and portable devices and surrounding this technology with more traditional curricular materials—such as music, poem posters, letter flip charts, and sight word cards—that supplement my instruction in early literacy and other cognitive and motor skills. The program is based upon the theory of multisensory instruction, instruction that addresses the unique learning styles (Gardner, 1993) and needs of each student, allowing opportunities for whole body movement, physical manipulation of meaningful objects, and engaging learning opportunities using music, colors, textures, and sounds. As suggested by the theory of redundant signals (Montali & Lewandowski, 1996), the same stimuli presented via multiple sensory channels has a facilitative effect on comprehension, in that "individuals remember more of what is presented when information is delivered bimodally" (p. 272). Using multisensory components, The Literacy Center provides multiple and diverse avenues for learning foundational literacy skills, incorporating different modalities, embedded repetition, and frequent student practice within a naturally flowing instructional framework.

I noticed substantial progress in phonological processing skills such as rhyming and sound segmentation.

At the heart of The Literacy Center is the LeapPad® personal learning tool, a portable reading platform based on the LeapFrog® Near Touch® technology, a system that allows children to read stories and words and receive aural assistance sound-by-sound, syllable-by-syllable, or word-by-word for the entire text. This technology allows books to be read by, with, or to a child simply by touching the text and has been found to facilitate literacy development among students with moderate to severe disabilities (Bulat, 2005a). Within The Literacy Center, students have access to interactive LeapPad book libraries that teach phonemic awareness, decoding, vocabulary, fluency, and comprehension skills.

Additional technology-enhanced devices in The Literacy Center include the LeapDesk™ workstation and the LeapMat™ learning surface, both of which teach phonemic awareness, letter knowledge, and decoding skills. The LeapDesk workstation includes upper and lower case plastic letters that can be manipulated as they are placed either in a holding tray or in interactive cards,

[1] LEAPFROG SCHOOLHOUSE, LEAPFROG, NEARTOUCH, LEAPPAD, LEAPDESK, LETTER FACTORY, FRIDGE PHONICS, IMAGINATION DESK, and LEAPMAT are trademarks or registered trademarks of LeapFrog Enterprises, Inc. ©2007 LeapFrog Enterprises, Inc. LeapFrog SchoolHouse is a division of LeapFrog Enterprises, Inc.

providing corrective audio feedback as students press letters, write letters, and use letters to spell words. The desk also assesses students in phonemic awareness, letter names, and letter sounds and automatically generates a variety of progress reports based on those assessments, including parent letters in both English and Spanish. The LeapMat learning surface is a colorful interactive mat that incorporates touch, sight, and sound to teach letter-name recognition, letter-sound association, and the spelling of three-letter words. On the mat is represented each letter of the alphabet; students touch or step on each letter to hear its name or sound. Students can use either the desk or the mat individually, in small groups, or as a whole class. Finally, The Literacy Center program also includes materials intended to be sent home for additional student practice, including the LeapFrog Fridge Phonics® magnetic letter set and the Letter Factory™ DVD.

Sample

My school serves approximately 450 K–6 students in a diverse suburban community just east of San Francisco. In addition to a resource room program, this school hosts my full-day special education class, which is open to K–1 students with severe cognitive impairments from any of our district schools. The school as a whole has adopted the Open Court Reading program. However, I have found Open Court too difficult for my students and thus supplement it with other more developmentally appropriate materials.

Without exception, all students showed progress in letter names and letter sounds over my second year of program use.

Implementation

In early April of 2005, I agreed to evaluate The Literacy Center in my class of twelve K–1 students; although their ages ranged from 5.5 to 7.0 years, the cognitive abilities of these students ranged from two years of age to first-grade ability. Nine were given parental consent to participate in this study; diagnoses for these students included high-functioning autism and mental retardation. Six were boys.

I used the program from the first week in April through the end of May, settling into a pattern of use that included individual practice, small-group activities, and whole-group instruction. In some cases, I styled learning stations after the TEACCH[2] method for teaching students with autism. For example, I structured the flow around the LeapDesk workstation in a way that emphasized the order in which materials were used: left-to-right organization to reinforce the left-to-right nature of print itself, with work to be done placed on the left of the station and finished product placed on the right. Student files were kept in predicable locations, allowing students to access them independently, which facilitated a sense of autonomy and ownership over their learning. Overall, my students used materials included in The Literacy Center for an average of 20-25 minutes each day, focusing largely on using

[2] http://www.autism-resources.com

LeapPad systems and corresponding books, the LeapDesk workstation, the LeapMat learning surface, and an included music cassette.[3] Activities incorporating the LeapMat learning surface included having students take turns finding the letters in their names on the mat, then writing the letters on their personal white boards; I also used the practice option within the LeapMat surface to encourage small groups to practice finding letters based on their names and sounds. The LeapDesk workstation was largely used singly or in pairs, allowing students to work together on letter identification and spelling. My students—even those unable to decode—used the LeapPad book platforms independently, repeatedly "reading" books using the audio supports until able to read the book without any scaffolding. In addition, I often worked with students on LeapPad systems, modeling awareness of print, comprehension strategies, and word analysis. Shortly after implementing the program, I began to send home with some of my students LeapPad systems and books, Fridge Phonics magnetic letter sets, and copies of the Letter Factory video to provide additional literacy practice outside of the classroom.

TEACCH: Treatment and Education of Autistic and Communication-Handicapped Children[2]

TEACCH is a program for autistic individuals using a combination of approaches and methods. The major thrust of TEACCH is to optimize the communication skills and autonomy of the child, using education as a means to achieve that goal.

- TEACCH assessments focus on a child's potential, not deficits
- Instructional strategies target underlying conditions that will foster learning experiences
- Behavioral problems are addressed through a focus on underlying causes
- The environment is modified to be simple and predictable
- The individual is given a means of communication and expression that may be unique to her/him

In late March, just prior to implementing the program, I assessed each student on letter names and letter sounds using the LeapDesk workstation.[4] These assessments not only captured students' abilities before program implementation, but also allowed me to then use the LeapDesk station to individualize instruction. The LeapDesk workstation recorded each student's assessment performance and tailored exposure to specific letter

[3] Students also had access to the LeapFrog Letter Factory video and an Imagination Desk™ learning center.

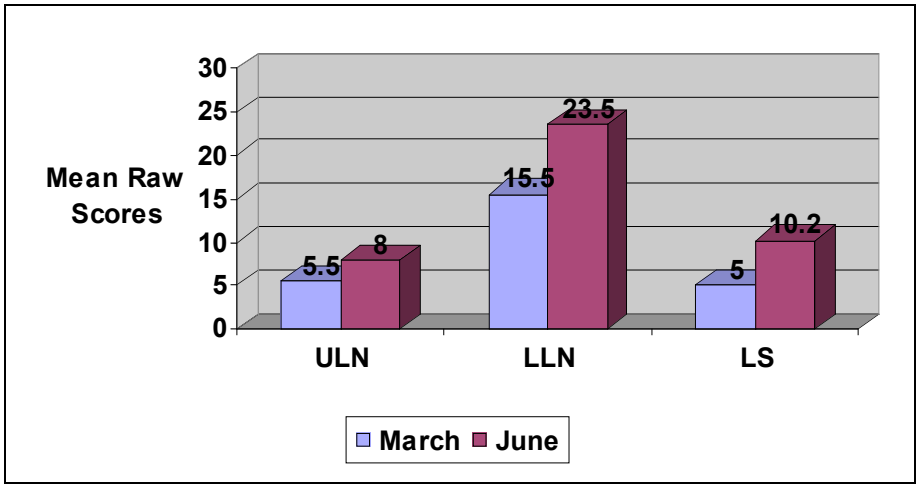
[4] Upper- and lowercase letter name assessments included a total of 26 stimuli. The letter sound assessment tested long and short forms of vowels as well as alternate sounds for *c* and *g*, for a total of 33 stimuli.

names and letter sounds according to each child's needs. In this way, the LeapDesk station became a personalized center activity for students, allowing them to repeatedly touch, hear, and see the letter names and sounds they needed to work on. In addition, based on students' assessments, the LeapDesk workstation generated activities that I sent home for students to complete with their parents.

Results

Academic Skill Performance. My students were tested again on the LeapDesk workstation in early June. After using The Literacy Center for seven weeks, nearly all of my students showed notable improvement in both upper and lowercase letter name identification as well as in letter sound knowledge. Overall, my students gained 45% in uppercase letter name knowledge, gained 52% in lowercase letter name knowledge, and doubled their letter sound knowledge (Figure 1). In addition, while I did not directly test phonology, I noticed substantial progress in phonological processing skills such as rhyming and sound segmentation. Unexpectedly, I also witnessed improvements in students' levels of independence and time on task. Students who had previously been unable to work independently were able to do so using the supports and feedback provided by the Literacy Center components. Even my lowest achieving students were able to understand how to retrieve their equipment and set it up, using the embedded audio support to guide their use.

Figure 1: 2005 implementation: Growth in skill, pre- to post-test (n=9)



ULN: Uppercase Letter Names; LLN: Lowercase Letter Names; LS: Letter Sounds

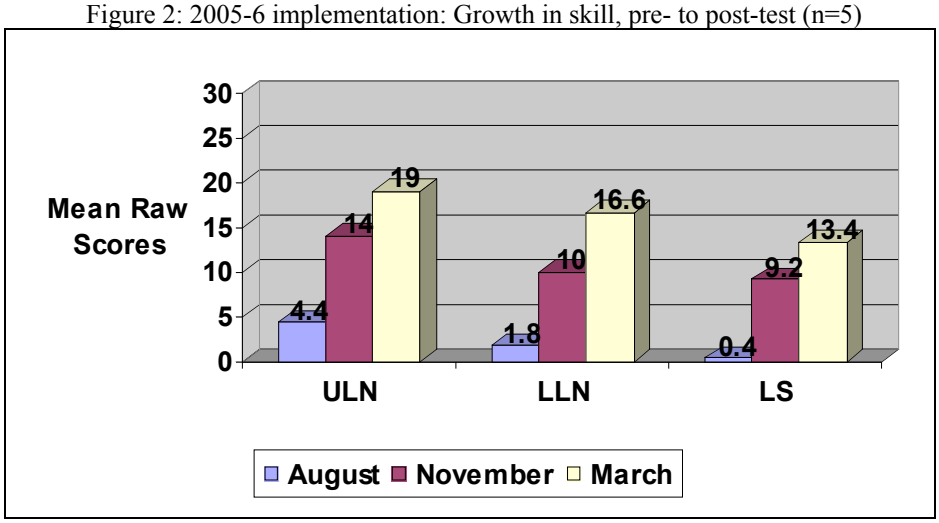
I also found the assessments embedded within the LeapDesk workstation more suitable for these particular students than district-mandated assessments. District assessments require the student to respond verbally, an unreasonable constraint for students with speech and language impairments, and they primarily reinforce what I already know: that my students are not performing at grade level. By contrast, LeapDesk assessments are highly visual and kinesthetic activities, allowing the student to respond by pressing letters in a console. They thus more accurately measure students' true abilities, identifying

skills already mastered as well as those needing practice. I used that information to guide both classroom instruction and the development of individual student goals.

Behavioral Gains. As part of my classroom management, I allowed my students to trade LeapPad™ books upon completing their assignments, which they brokered on their own, thus fostering cooperative social skills. This type of activity increased levels of engagement and independence and resulted in fewer behavioral outbursts and a greater sense of student autonomy, in particular for my students with autism. In addition, for these students wearing the headphones that accompanied the materials substantially reduced auditory distractions, allowing them to concentrate more effectively on the learning task at hand.

Links to IEP Goals. Reports from the LeapDesk assessments document students' progress over time and identify skills for continued improvement; consequently, I often used these reports to prepare Individual Education Plans (IEPs) for my students. During this investigation, I quickly discovered that The Literacy Center supported my students' social and behavioral as well as academic goals. For example, a student working on an IEP goal of increased concentration on learning tasks was able to use the LeapDesk station with headphones, an inherently motivating and calming activity that simultaneously improved student focus while fostering academic growth. Similarly, a social interaction goal of peer interaction was facilitated by having students take turns at a LeapFrog station, or encouraging students to trade books when finished reading.

Figure 2: 2005-6 implementation: Growth in skill, pre- to post-test (n=5)



ULN: Uppercase Letter Names; LLN: Lowercase Letter Names; LS: Letter Sounds

2005-6 IMPLEMENTATION

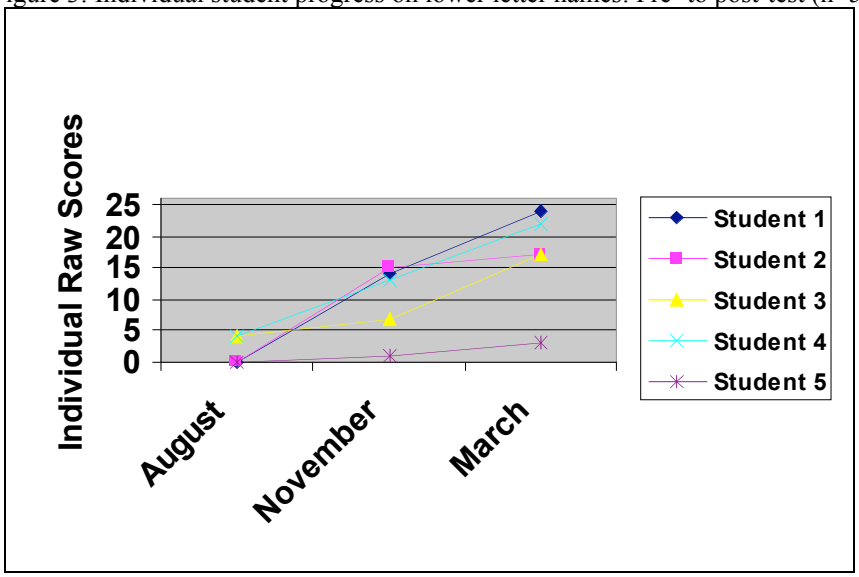
I continued using The Literacy Center the following school year with a new group of students, five of whom were given parental permission to participate in this second study. Even though they were lower-achieving overall than the prior year's students, I implemented The Literacy Center materials with this cohort of students in much the same manner, using the same set of materials for

approximately 20 to 25 minutes per day. Students were pre-tested on letter names and letter sounds in late August 2005 using the LeapDesk workstation; students were reassessed in November 2005 and again in March 2006 (Figure 2).

Results

Without exception, all students showed progress in letter names and letter sounds over my second year of program use; overall, student scores roughly doubled (Figure 3). One student unable to test at the beginning of the year was able to identify 61.5% of upper case letters and 57.7% of lower case letters in November. Another non-verbal student progressed from 12 to 22 correctly identified upper case letter names, and from 4 to 17 correctly identified lower case letter names between assessments. Once again, I also saw notable improvement in student autonomy, motivation, and behavior. One child in particular was designated as "below-average intellectual functioning." During fall pre-testing this student was untestable, as he couldn't follow basic testing directions. By the end of the school year, this same child was able to demonstrate mastery of all of his letters and letter sounds, and I was able to advocate changing his status from "mental retardation" to "speech/language impairment." Furthermore, these students loved the materials, many of which gave them a sense of ownership over their learning. The materials allowed students to be in control of their own learning, fostering not only success but also peer tutoring, in which students would pair up to "teach" each other. This kind of social engagement further fostered pride and developed important interpersonal skills.

Figure 3: Individual student progress on lower letter names: Pre- to post-test (n=5)



CONCLUSION

For students struggling with severe cognitive, auditory, and physical limitations, academic progress can be an elusive goal with demonstrable gains appearing only after long periods of intensive intervention. It is a goal, however, that not only is the birthright of every child but that is also mandated by federal legislation ("Individuals with Disabilities Act Amendments of 1997"). In my experi-

ence, young children with severe cognitive impairments showed remarkable academic, behavioral, and social gains after using the Literacy Center program. Even the most severely handicapped students gravitated to the multisensory materials and were able to work more independently and with greater success than they had otherwise experienced. Negative behaviors diminished, focus increased, and students achieved a sense of autonomy in their learning. The program also provided a fresh mechanism for involving parents in their child's education. While I did not document home use of materials, informal parent reports suggested that the materials were used, were used in ways that fostered parent-child interactions, and supported the academic goals of the children. Repetition is a key ingredient in the effective instruction of basic pre-reading and reading skills such as letter knowledge, phonological concepts, and vocabulary (Crozer, 1996), and for greatest impact repetitions must be provided consistently and at each opportunity for learning. Sending materials home gave students more targeted practice than they would have otherwise received. It also gave me a chance to interact regularly with their parents, something not always easy to accomplish outside of regular IEP meetings.

I also learned as a result of using this program. With the exception of videos and computer-based skill games, technology had previously not played a significant role in the instruction of my students. It was technology used to instruct and entertain, but nothing with which the students themselves could interact independently. The type of technology used in The Literacy Center, however, was something students could use independently, with built-in supports and audio-feedback scaffolding that provided both direct instruction and repetitive practice. Whether practicing letters on the LeapDesk workstation, reading interactive LeapPad books, or playing bingo on the LeapMat surface, even my lowest-achieving students used the components and learned from them.

The students in my special day class are generally not candidates for the regular core curriculum. While I continue to use a variety of materials and techniques in my classroom, I do believe that The Literacy Center provides critical literacy instruction designed specifically to address my students' weak areas in ways that captivate them and foster an enthusiasm for learning. The Literacy Center program has played a key role in exposing my students to, and providing explicit instruction in, the skills needed to ultimately move them through the special education system and into the least restrictive environments possible.

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