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The Impact of a Modified Repeated-Reading Strategy Paired with Optical Character Recognition on the Reading Rates of Students with Visual Impairments

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Abstract: The repeated-reading strategy and optical character recognition were paired to demonstrate a functional relationship between the combined strategies and two factors: the reading rates of students with visual impairments and the students' self-perceptions, or attitudes, toward reading. The results indicated that all five students increased their reading rates, and four students' attitudes toward reading improved.

The risk of poor academic performance and the potential for frustration that is associated with slow reading speed has been a topic of concern for students with visual impairments (that is, those who are blind or have low vision) for more than a decade (Corn et al., 2002). Students with visual impairments often have slow reading rates (Fellenius, 1999; LaGrow, 1981), and slow reading rates have a negative impact on the acquisition of literacy skills (Koenig & Holbrook, 1991). Negative attitudes toward braille, large print, or

reading in general may also affect reading performance (Erin & Sumranveth, 1995; Frank, 2000). A significant role for teachers of students with visual impairments (hereafter vision teachers) is to address their students' slow reading rates and attitudinal barriers through the use of appropriate instructional strategies and assistive technology tools.

Two major factors that lead to slower reading rates among students with visual impairments are the type of visual impairment and visual acuity, with lower visual acuity resulting in reduced reading rates (Krischer & Meissen, 1983). Furthermore, the disparity between the reading rates of sighted students and students with low vision increases as students progress to middle school and high school (Corn et al., 2002).

Instructional strategies have been identified that can increase the reading rates of individuals with visual impairments. Olsen, Harlow, and Williams (1977) improved the reading rates of users of large print and braille with a direct-instruction approach of rapid-reading techniques by which the participants were helped to break old reading habits, such as rereading and voicing. Fridal, Jansen, and Klindt (1981) used a similar approach, providing further evidence that direct instruction can result in higher reading rates for students with visual impairments.

The direct-instruction strategy of repeated reading has been established as a valid method for improving

reading efficiency for sighted students (Rasinski, 2000). This strategy requires students to reread passages until predetermined levels of comprehension and reading rate are achieved. With repeated readings, error rates decrease and reading fluency increases. As students are able to decode more automatically, comprehension increases. Using a changing criterion, single-subject design, Layton and Koenig (1998) evaluated the effectiveness of the repeated-reading strategy with four elementary-level students with low vision. They found that three students' reading rates improved significantly and that the fourth student's reading rate improved moderately. All four students retained their greater fluency during the maintenance phase.

Assistive technology devices may also be used to enhance both independence and reading performance. Some of these devices include low vision devices, such as magnifiers or slant boards; screen-magnification software; screen-reading software; auditory alternatives, such as four-track tape systems; and optical character recognition (OCR) programs. Enlarging printed material with low vision devices or through electronic magnification has been found to increase the reading rates of individuals who are visually impaired (Corn et al., 2002; Lovie-Kitchen & Whittaker 1998; Mangold & Mangold, 1989). In addition, LaGrow (1981) demonstrated the effectiveness of closed-circuit television training in improving the reading rates of six college-bound

students.

The impact of OCR programs on improving reading rates is of particular interest. OCR programs provide a means of scanning print material and translating it into an electronic format that can be directly accessed from a computer. Students with visual impairments can then use either screen-reading software or screen-enlarging programs, paired with OCR programs, to expand their access to print materials. Several theoretical perceptions regarding the potential of OCR to support literacy skills and increase access to print materials have been reported. Some of the benefits attributed to the use of OCR are that OCR requires less specialized training, allowing for greater reading speeds, and provides a way to circumvent deficiencies in decoding (Goodrich, Bennett, De l'Aune, Lauer, H., & Mowinski, 1979; Higgins & Raskind, 1997). However, there are limited empirical data to support these theories for school-aged students with visual impairments (Edwards & Lewis, 1998).

Attitudes toward reading and self-perceptions of reading abilities are additional factors that can affect reading performance. In addition to slow reading, several other factors may result in attitudinal problems: gender (Baker & Wigfield, 1999), achievement (Lazarus & Callahan, 2000), cognitive ability (Ivey 1999), grade level (Ivey & Broaddus, 2000), purpose of reading (Ley, Schaer, & Dismukes, 1994), access to reading materials (Fellenius, 1996), and instructional

strategies (Vollands, Topping, & Evans, 1999). Some main themes that have been found in research are that attitudinal issues are as varied and complex as the individual reader, attitudes have an impact on the time spent in reading activities, attitudes vary with the context of reading, attitudes improve when the reader is engaged, and there is a need to monitor and address attitudinal issues over time. Additional attitudinal barriers may be encountered when visually impaired students have difficulty with tactile recognition, recall of braille code, resistance to braille, visual fatigue, and dissatisfaction with the quality of large-print materials (Erin & Sumranveth, 1995: Frank, 2000; Krischer & Meissen, 1983). Students with visual impairments who are slow readers may also have negative perceptions of their reading skills that may influence their attitudes toward reading.

Students' attitudes toward their reading abilities because of their slow reading rates may become more positive when the students achieve higher reading rates. Increasing reading rates has been accomplished through the use of the repeated-reading strategy. However, the use of OCR software in addition to repeated reading may be a more efficient strategy because of the independence it provides. The purpose of this study was to demonstrate a functional relationship between a modified repeated-reading strategy, paired with OCR computer-assisted reading software, and an increase in the word-per-minute (wpm) reading rate of students with visual impairments

and students' higher self-perceptions of their reading abilities.

Method

Participants

The participants were selected from a large urban school system in northern Georgia on the basis of the following criteria: (1) they were receiving services in a vision resource program; (2) they were aged 11–14; (3) they were within the average range of cognitive abilities (scores above 80 on either a verbal or a performance subtest); (4) they used standard print, large-print, or braille as their primary medium; (5) they had a slow reading rate, defined as a wpm reading rate that was 10% below the lowest average wpm rate for their current grade level; (6) they had a low-average (or below) rating on two of the five subscales of the Reader Self-Perception Scale (RSPS; Henk & Melnick, 1995); and (7) they indicated in a brief, structured interview that they wanted to participate. It was also decided to include students who had low ratings on self-perception, regardless of their reading rates.

Five participants met the criteria for inclusion in the study (see Table 1). On the basis of the results of individualized learning media assessments, their media preferences included standard print, large print, and braille. At the time of the study, none of the participants was using optical aides for leisure-reading

assignments or was receiving any other specialized literacy instruction. Each participant's independent reading level was determined by administering the expository form of the Johns Basic Reading Inventory (Johns, 2000), and the levels were found to range from the fifth to the sixth grade. The current average wpm reading rate was determined during the informal reading inventory and ranged from 33 to 145 wpm. Carver's silent-reading rates were used for comparison, since they are considered to be the most accepted comprehensive wpm reading rates for older students (Johns, 2000; Layton & Koenig, 1998). The RSPS was administered in each participant's preferred medium (print, large print, or braille). This 33-question survey, which is designed for students in grades 3–8, provided scores across five scales: General Perception, Progress, Observational Comparison, Social Feedback, and Physiological States. Scores from each scale were categorized as high, average, or low (Henk & Melnick, 1995). All five participants had at least two categories with low to low-average scores. (The abilities scores were obtained from a review of the students' existing records. No individualized abilities assessments were administered.)

Materials

Two computers with scanners, headphones, and the Kurzweil 1000 OCR voiced reading software were part of the assistive technology available in the middle school vision resource room selected for the study. A

Juliet braille embossing printer and the Megadots braille-translation software were used to produce materials in braille format. Each computer was equipped with the Microsoft Word 2000 software package and an inkjet printer. The Microsoft Excel Spreadsheet software was used to compute data, create figures, and develop linear trend lines. Two tabletop cassette recorders from the American Printing House for the Blind were available for the vision teacher to produce audio materials.

The Assessment Kit (Sewell, 2001), an evaluation instrument that includes standard print, large-print, and braille versions of the Basic Reading Inventory (Johns, 2000), was used to determine independent reading levels. Brief reading selections from *Six-Way Paragraphs* (Pauk, 1983) and the intermediate and junior high school levels of *Reading Stories for Comprehension Success* (Hall, 2000a, 2000b) were used during both the baseline and intervention phases to accommodate the time frame of the sessions. These reproducible short stories were one page in length, provided a grade level for each title, included both narrative and expository pieces, and contained 15–20 reading samples for each grade level. The standard print selections were scanned using Kurzweil 1000 and saved as both a Kurzweil and a text file. The text file was exported into Microsoft Word 2000 and Megadots to produce large-print and braille selections. An 18-point Verdana font was used to produce the large-print samples.

Procedure

OCR training

The intervention phase required the participants to use the Kurzweil 1000 OCR reading software program. Prior to the baseline phase, the participants demonstrated their skill levels with the basic reading commands required to operate this software. A checklist of basic skills was developed that covered opening commands (for example, open program, load preferred reading configuration file, locate specific file), display and reading commands (for example, adjust font size and reading rate, set preferred reading mode, rewind and fast-forward reading cursor, start and stop reading, locate bookmarks), and closing commands (for example, close file, exit program).

Practice sessions were provided until each participant was able to complete at least 85% of the steps without prompting. The participants created individual user-preference files for rate, font, magnification, highlighting, tracking, and background. Independence with this software was not a prerequisite, and assistance from the vision teacher was available during the intervention phase.

Modified repeated-reading instruction paired with OCR

Sessions were conducted on alternating days by the

certified vision teacher during a student's regularly scheduled time in the resource room. During each intervention session, wpm rates, error rates, and comprehension scores were recorded. Carver (1990) suggested that a more accurate reading rate can be obtained by using a standard wpm rate. Counting the number of characters and spaces in each passage and dividing that sum by 6 determined the standard number of words for a passage. The standard wpm rate was calculated by dividing the standard number of words in a selection by the total number of seconds needed to read the passage and then multiplying that quotient by 60.

Data on error rates were collected to verify that as the reading rate increased, the error rate remained stable. The error rate was determined by tallying the number of significant miscues in a passage. Significant miscues were uncorrected errors that affected the meaning of the passage (Johns, 2000). Errors related to proper names and places were counted as only one error even if they were repeated incorrectly throughout the selection.

Using baseline data, we established a final wpm goal rate for each participant. The final improvement criteria varied according to the participant's degree of divergence from the grade level average reading rate (Carver, 1990). Progress results from Layton and Koenig (1998) were used to determine realistic final goals. Between the baseline wpm rate and the final

wpm goal rate, interim wpm reading rates were determined on the basis of the changing criterion design (discussed later).

During each session, the participants first read a selection orally that fell within their independent reading level. A wpm reading rate and significant error rate were calculated. If the predetermined interim rate was not met on the initial reading, the participants completed a paired reading of the same selection using the Kurzweil 1000 OCR software. The OCR reading rate was set at a rate of 20–30 words above the criterion rate. This variance in rate was recommended because students are able to follow text at a much higher rate than their oral reading rate (Olsen et al., 1977). The participants silently tracked the reading cursor on the monitor as the OCR software read orally. The participant who used braille tracked and read a braille copy of the text silently.

Following the Kurzweil OCR reading, each participant completed a second oral reading, and his or her wpm and error rates were computed. Wpm rates and error rates were recorded and shared following each oral reading. The teacher and participant completed the calculations together as a way of monitoring the accuracy of the calculations. The participants received either encouragement or positive feedback regarding their progress.

If the criterion was not met on the second oral reading,

a second Kurzweil OCR reading was performed, followed by an oral reading. The procedure allowed for a maximum of three oral readings and two OCR readings (oral reading, OCR, oral reading, OCR, oral reading). During each session, the intervention was used until the criterion was met, a participant displayed visual fatigue or frustration, three oral readings were completed, or the 30-minute time frame expired.

Comprehension was evaluated after the final oral reading of each session using the holistic retelling strategy. Comprehension was assessed to ensure that while the participants increased their wpm rates, they were able to comprehend the selections and not just decode words at a greater increased rate. The selections within the reading samples included both literary and expository pieces, and the holistic retelling strategy provides a means of assessing both genres (Johns, 2000).

An adapted holistic retelling checklist (Johns, 2000) was used to determine the comprehension score at the end of each session. Depending on the content and richness of the retelling, a score of 1–5 was earned on eight criteria (generalizes text, thesis, major points, supporting details, supplementations, coherence, completeness, and comprehensibility). A nominal rating of pass or fail was applied to the comprehension score; an overall average score of 3 or above reflected a passing score. When a participant was unable to demonstrate a passing comprehension score, a lower-

level selection was presented for subsequent sessions.

Attitudinal survey

The RSPS (Henk & Melnick, 1995) was administered at the time the participants were selected and during the final week of the study. Raw scores were categorized as high, average, or low ratings for each of the survey's five scales. To assess the social validity of the interventions, a brief structured interview was conducted at the conclusion of the study using a modified form of the preliminary interview.

Design

A changing-criterion design (Alberto & Troutman, 2003) was used to demonstrate a functional relationship between higher standard wpm reading rates of students with visual impairments and the use a modified repeated-reading strategy paired with OCR software. This design is appropriate for assessing behaviors that may change slowly over time (Schloss & Smith, 1999). Data gathered during the baseline phase were used to establish an individualized improved reading rate to be achieved in increments across sequential changing phases.

Baseline

During the baseline phase, data were collected to establish a mean wpm rate, error rate, and comprehension score at the student's independent

reading level using selections from *Six-Way Paragraphs* (Pauk, 1983). Data were gathered until a stable wpm baseline was established. A stable baseline was defined as a variance of no more than 20 words on any two readings over a minimum of five sessions. Baseline sessions were recorded on audiocassette to collect reliability data and to allow the participants to become comfortable with the process of the intervention phase.

The participants were informed that during the oral reading, the vision teacher would not correct any mispronunciations, omissions, or errors. No additional rereadings were conducted during the baseline phase. Comprehension was assessed using the holistic retelling approach (Johns, 2000). During the baseline phase, comprehension was assessed to ensure that the participants were given materials that were within their independent reading level and to allow the participants to become comfortable with the holistic retelling approach.

The participants were not given feedback regarding their performance during baseline sessions, but were given encouragement at the conclusion of each session. Once a stable baseline (within a minimum of five sessions) was reached, the mean of the baseline wpm rate was used to determine both the initial and final criterion levels of the intervention phase. The baseline average wpm rate was shared with the participants at the end of the baseline phase, so the students could

participate in setting their goal rates.

Intervention

Sessions were conducted by the vision teacher on alternating days during a participant's regularly scheduled time for instruction in the vision resource room. On the basis of the results of Layton and Koenig's (1998) study, a final criterion goal of 83% above the mean of each participant's stable baseline wpm rate was established as a final criterion reading rate. Students who were participating to improve their attitudes toward reading or whose baseline wpm rate was within 35% of the reading rate for their current grade level set a final oral reading rate 25% to 50% above their baseline mean reading rate (Carver, 1990).

One of three methods was used to set the interim criterion rates for the changing criterion phases: a wpm goal of 50% above the mean of the previous phase, a new rate that was the mean of the highest wpm rates from the previous phase, or a new rate that was the same as the highest wpm rate achieved in the previous phase (Alberto & Troutman, 2003; Layton & Koenig, 1998). Professional judgment was also used to set appropriate wpm rates. The interim level was achieved when a participant reached the set criterion on two out of three sessions within a phase. The participants had an opportunity to adjust the criterion at the beginning of any phase if they felt that the change in reading rate was either too rapid or too minimal an increase. The

intervention phase continued for nine weeks across a minimum of three changing-criterion phases. Four of the five participants were able to complete a fourth changing-criterion phase.

Interobserver reliability and social validity

Reliability data were collected on reading rates, error rates, and comprehension during both the baseline and intervention phases. Using audiotapes and direct observation, two additional researchers were trained in the methods of recording miscues, wpm rates, and comprehension scores. Interobserver data were collected on 20% of each participant's sessions.

During the intervention phase, a reliability score of 80% was considered acceptable for wpm, error rate, and comprehension. The reliability coefficient for wpm reading rate was computed by dividing the lower time by the higher time and converting that quotient to a percentage. Reliability for wpm rates did not fall below 98% for any session in which reliability data were collected. Error reliability was the sum of agreed-upon significant errors divided by the sum of total errors that were found by both the researcher and the observer. Because of relatively few significant errors, reliability for significant errors ranged from 66% to 100%, with a mean of 82.4%. Reliability of comprehension was determined by comparing the number of sessions on which the observer and researcher reached agreement regarding overall comprehension (pass/fail) by the total

number of passages in which reliability data on comprehension were gathered. Using this nominal scale, we found that reliability for comprehension was 100%. The observer reviewed and recalculated each participant's pre- and post-RSPS score, and a reliability coefficient of 100% was obtained.

Results

All the participants' reading rates improved with the use of the modified instructional strategy of repeated readings, paired with the OCR software. Four of the five participants reached the final wpm goal rate, and the fifth student was making steady progress toward achieving this goal. The wpm rates of all the participants increased, the error rates decreased, and comprehension was maintained. Four of the five students also had more positive perceptions of their progress in reading.

Reading Rates

Chris

Chris achieved a stable baseline rate of 149 wpm within five consecutive sessions using standard print as his preferred medium. An overall improved repeated-reading rate of 25% above the baseline rate was agreed to as appropriate. This final wpm goal rate (186 wpm) would increase his reading rate by 37 words and would be above the average reading rate for his grade level.

An interim-goal rate of 159 wpm was set for the first changing-criterion phase, which was the highest wpm rate within Chris's baseline phase.

Chris made steady progress in the first to third changing-criterion intervention phases. In the first phase, he reached the criterion goal on the initial readings of his first two sessions. He did not need to incorporate a repeated reading or to use the Kurzweil OCR until the eighth session. For the second phase, the highest wpm rate from the previous phase was again selected. During this phase, Chris did need to use repeated readings in two out of three sessions. For the third phase, the average wpm rate from the repeated readings of the previous phase was used (184 wpm). During this phase, Chris met the criterion in all three of his second readings. His average rate in this phase, 207 wpm, exceeded the final goal rate. His average initial rate during this phase was 19 wpm above his initial baseline reading rate.

For the fourth phase, a 190 wpm rate was set, which was above the final goal of 185 wpm established during the baseline phase. During Session 15 of the final phase, Chris needed to complete a third oral reading, but he exceeded the 190 wpm criterion by 17 words. Chris achieved an average of 173 wpm on initial readings during this final phase, a 16% improvement overall for the initial readings. His average wpm rate for above-criterion readings during the final phase was 206 wpm, which was a 38%

improvement over his baseline wpm average.

Error rates and comprehension remained stable for Chris throughout the intervention phase. Error rates ranged from 0 to 5 errors on first readings (1.06 mean error rate) and 0 to 3 errors on repeated readings (.44 mean error rate). The one time that Chris made 5 errors during his first reading (Session 15), the topic of the story related to Greek mythology and included several Greek names. Using the holistic retelling scale of 1–5, Chris obtained an average comprehension score of 4.9% over 17 sessions (see Figure 1).

Melissa

Melissa obtained a baseline mean of 104 wpm, with a range of 13 words within five sessions using standard print as her preferred medium. Since she was within 33% of the grade-level average, a final wpm goal rate of 160 wpm was set, which was 50% above the mean of the baseline rate. For the first intervention phase, an interim criterion was set at 140 wpm, a 35% increase.

Melissa met the criteria in the first three changing-criterion intervention phases. During the first phase, she achieved the target interim wpm rate in the first two out of three sessions by using a third oral reading. The goal was increased to 145 wpm for the second phase. In three out of four sessions, Melissa required a third reading. However, in the final session of this phase, Melissa exceeded the goal by 11 words on the

initial reading. For the third phase, a goal of 150 wpm was established because Melissa felt comfortable improving at a rate of 5 wpm across the changing phases. In setting the goal for the third phase, she expressed doubt about her improvement because she noted the range in her initial reading rates during the previous phase (35 wpm). Melissa achieved the 150 wpm rate within five sessions, but she required a third reading in four of the five sessions.

The original final goal of 160 wpm was kept for the fourth phase. Melissa achieved the goal in three out of three sessions. During the final phase, she obtained a mean of 169 wpm on her final readings, a 63% improvement over her baseline mean. Her mean for initial readings during the final phase was 132 wpm, a 27% improvement over her baseline rate. Throughout the course of the study, Melissa demonstrated a broad range of 60 words in her initial reading rate. The mean of her initial readings during all four changing-criterion phases was 124 wpm, an overall improvement of 19% above the baseline mean.

Melissa's error rates decreased as her reading rates increased. During the first readings, Melissa's mean error rate was 1.25 errors. Melissa exhibited 0 errors on all the repeated readings. Using the holistic retelling strategy, Melissa obtained an average comprehension score of 4.1, scoring 3 in only 6 out of 20 sessions (see Figure 2).

Nick

Nick achieved a baseline average of 52 wpm within five sessions using large print as his preferred medium. Using materials at the sixth-grade level, he attained a comprehension score of 2 at the end of the second session, which was verified with interobserver data. As a result, Nick was given materials at the fifth-grade level for the remainder of the study to minimize his frustration and maximize his comprehension. A final wpm goal rate of 95 wpm, 83% above his baseline rate, was agreed to as appropriate. To initiate the intervention phase, the first interim changing-criterion goal was set at 78 wpm, 50% above the mean of the baseline rate.

Nick achieved the goal rate within each changing-criterion intervention phase. During the first phase, he achieved the target interim goal on the second oral reading during the first three sessions. Using the highest rate from the first phase, a goal of 86 wpm was set for the second phase. Nick achieved this goal in the second and third sessions using a third oral reading. For the third phase, the goal was set at 91 wpm. Nick was aware that he could use a fourth changing-criterion phase, and mastery of his interim goal was an important motivational factor. Five sessions were required to meet the third-phase goal, and four of the sessions required a third reading.

The final fourth-phase goal (95 wpm) was set at 83%

above the baseline, and Nick met the goal in three out of three sessions. Nick achieved a mean of 71 wpm on initial readings during the final phase, a 37% improvement over the baseline reading rate. In the final phase, he achieved an above-criterion mean rate of 109 wpm, which was 109.6% above the mean of his baseline reading rate.

Nick's error rates decreased as his repeated-reading rates increased. Over the course of the study, Nick had a mean error rate of 3.47 on initial readings and 1.92 on final readings. He admitted that being able to identify and discuss decoding errors helped him reduce his errors. With the exception of the second session, Nick obtained an average comprehension score of 3.72 (see Figure 3).

Michael

The reading inventory placed Michael's independent reading level at the sixth-grade level. However, on the initial reading, he obtained a score of 2 on comprehension, which was verified with the interobserver results. For the remainder of the study, Michael used materials at the fifth-grade reading level to ensure that he was reading materials that would not reach an instructional or frustrational level. He used large print as his preferred medium. Using the baseline mean rate of 55 wpm, a final wpm goal rate of 101 wpm was set, which was 83% above the baseline. The initial interim goal of 50% above the mean of the

baseline phase, 83 wpm, was thought to be too high, so a goal of 80 wpm was agreed on for the first changing-criterion phase.

Michael reached the changing-criterion goal in the three intervention phases, but was unable to reach the final 101 wpm goal rate. During the first intervention phase, he reached his goal in the last three of five sessions by using a third oral reading in all but one session. His improved initial reading rate for this phase was a mean of 65 wpm, 10 wpm above the baseline initial reading rate. A goal of 83 wpm was set for the second changing-criterion phase, 1 word below the mean of the highest wpm rate of the previous phase. Michael achieved this rate in the first, third, and fourth sessions. He continued to require a third oral reading for all four sessions in this phase and obtained a range of 74–91 wpm on the third oral reading (mean 85 wpm). His initial wpm reading rate during the second changing-criterion phase ranged from 49 wpm to 66 wpm, with a mean initial reading rate of 62 wpm.

On the basis of his progress in the two previous phases, a goal of 2 words above the previous phase (85 wpm) was set for the third phase, which Michael reached using a third reading. During this phase, time limitations during two of the sessions did not allow for a third reading, but Michael achieved the goal after a total of four sessions.

Michael demonstrated a 67% improved repeated-

reading rate over his baseline rate and required third oral readings. His mean initial reading rate during the final phase was 59 wpm, with a range of 47 wpm to 73 wpm. This rate was an overall improvement of 7% above his initial reading rate in the baseline phase.

Michael reduced his significant errors with repeated readings. As his reading rate increased, significant errors decreased. A mean error rate of 3.65 words on the initial readings dropped to a mean of 1.8 words on the final readings. For the purposes of this study, repetitions were not scored as significant errors. However, on the data sheets, we noted that Michael's fluency was affected by repetitions of phrases and single words. After the first reading, comprehension remained stable, with a mean holistic retelling comprehension score of 3.76 (see Figure 4).

Serena

Serena obtained a mean baseline rate of 35 wpm, with a range of 7 words (39 wpm to 32 wpm), using braille as her preferred medium. A final wpm goal rate of 64 wpm, 83% above the mean of the baseline phase, was set. For the first changing-criterion phase, Serena was motivated to set an interim goal of 53 wpm, 50% above the mean of the baseline phase. However, we felt that initial success was important to maintain her motivation and minimize her frustration. Therefore, the first interim changing-criterion rate was set at 45 wpm, a 10-word improvement over the baseline mean.

During the first three changing-criterion phases, Serena reached the goal and was able to reach the final goal rate in the fourth phase. She achieved the first changing-criterion goal rate in her first three sessions and required only a second oral reading for each session. During the paired OCR readings, Serena reported that she was satisfied with her ability to track the braille at the same rate as the oral reading rate of the software. The goal rate for the second phase was set at 57 wpm, the highest rate from the previous phase. This phase did require a third oral reading in two of the four sessions. Serena obtained a mean of 37 wpm on initial readings, a 6% gain over her baseline initial reading rate. An above-criterion mean of 58 wpm was obtained, which was a 66% improvement over the baseline initial reading rate. For the third phase, the highest rate from the previous phase was used (59 wpm). Serena achieved this rate in the first two of three sessions. A mean of 66 wpm above the criterion indicated an 87% improvement in repeated readings. Initial readings showed a mean of 39 wpm, an 11% improvement over her initial reading rate in the baseline phase.

The goal of the fourth phase was set at 64 wpm, as agreed at the beginning of the intervention phase. On the second session of this phase, time ran out, and Serena was unable to complete a third reading. She did reach her goal on the last two of four sessions and obtained a mean rate above the criterion of 68 wpm.

Serena made a 94% improvement with repeated readings. Her initial mean reading rate during the final phase was 40 wpm, a 14% improvement for initial readings.

Serena made relatively few significant errors on initial readings (mean of 1.8), and her errors decreased with repeated readings (mean .26). Retelling was rich with detail and included supplemental information. She obtained a mean comprehension score of 4.42 (see Figure 5).

Self-perception

Four of the five students had increases between the pre- and post-administration of the RSPS (see Table 2). Chris made an overall gain of 11 points. His most significant gain was on the Physiological States subscale, going from a low-average range to a high-average range. Chris's improvement on the Self-perception subscale was indicated by his answers to questions such as these: I like to read aloud (from disagree to agree), reading makes me feel happy inside (from undecided to agree), and I feel comfortable when I read (from agree to strongly agree). During his selection interview, Chris said that he wanted to participate because he felt that learning to use the Kurzweil OCR software would provide him with alternative access to print that he might need to rely on in the future. During his postintervention interview, he reported that getting to his final goal took "longer than

I imagined." Chris stated that he felt he had made improvements in his reading rate and that he could complete his reading assignments "a lot faster." He also thought that being able to set personal preferences in the Kurzweil program (font, speed, magnification) made gaining access to print materials on the computer less demanding.

Melissa is the only participant whose scores on the RSPS decreased at the conclusion of the study. Although she achieved her final goal and made gains in both initial and repeated reading rates, her overall score on the RSPS dropped 15 points at the end of the study. Melissa's self-perception was lower on the General Perception, Progress, and Physiological States subscales. In her selection interview, she indicated that she wanted to participate because she felt uncomfortable when she was asked to read aloud in class. She admitted that she felt her rate and fluency were not in the same range as those of the other students in her class. In the closing interview, Melissa said that she was glad she participated, that she found out she "read normally," and that the project helped her with pronunciation. She thought that the OCR software "didn't help a lot," but that hearing and reading the passage over and over made her reading rate "go up." When asked about the duration of the individual sessions and the length of the study, Melissa said that both were "too long."

Nick showed improvement on two of the five subscales

of the RSPS and made an overall gain of 18 points. On the subscale, General Perception ("I think I am a good reader"), he improved from undecided to agree. The most significant area of improvement was in Progress, which rose from low (32/43) to high (44/45). His response to "I like to read aloud" went from strongly disagree to strongly agree. The preliminary interview indicated that Nick was often frustrated with reading activities and that he was uncomfortable "figuring out the words" when asked to read out loud in class. In the concluding interview, Nick stated that he felt his reading rate had improved, that reading was "less stressful," and that he never expected to get "above the 90s." He confirmed that hearing and seeing a selection on the computer made the next timed reading easier.

Michael made gains on the RSPS subscales of General Perception, Progress, and Observational Comparison. During his preliminary interview, he said that he wanted to increase his reading rate because it would help him to complete assignments on time. In the postintervention interview, Michael reported that the intervention "made me feel that I accomplished a goal." He also stated that the OCR software helped him sound out words to improve his second readings. Michael also said that the time "was just right," but that he would keep going if he was given the opportunity to do these activities in the future.

Serena made an overall gain of 28 points across three of the RSPS subscales (Progress, Social Feedback, and

Physiological States). She indicated a more positive response to questions such as these: "I read faster than I did before," "I don't have to try as hard as before," and "I enjoy reading" (Henk & Melnick, 1995). During the initial interview, Serena asked if her rate of reading meant she was "dumber" than the other students in her general education classes. She admitted that she avoided reading assignments and that reading aloud, even in the one-to-one setting of the resource room, caused her discomfort. In the concluding interview, Serena reported that "the project really helped my wpm rate." She also concluded that the OCR software improved both her speed and comprehension because "speed made it easier to understand what it is about." In several sessions, Serena commented that the subject matter of the stories was of interest to her and that she looked forward to reading the next story.

Discussion

Graphic analysis indicated that using the modified repeated-readings instructional approach, paired with OCR software, can increase students' reading rates. Error and comprehension analysis further indicated that this strategy can increase reading rates without increasing errors or decreasing comprehension. An increase in self-perception of reading abilities was also found.

The participants benefited from the ability to vary the method of establishing the criterion rate. Since

motivation and self-perception were obvious factors, setting goals that were perceived as achievable was critical. Although the percentage of increase varied, each participant was able to note progress and the achievement of his or her individual goal rate. The variance in progress can be related to the initial starting rates (35 wpm to 149 wpm). A similar overall variance, 14 wpm to 109 wpm, was noted for the participants in Layton and Koenig's (1998) study. Layton and Koenig found improvements ranging from 60% to 171%, an average of 89% for the four participants. Similarly, this study found a range of improvement from 38% to 109%, an average of 70% for the five participants. Both studies demonstrated continued growth in reading rates as a result of the repeated-reading strategy.

Self-perception was a factor that affected the participants' initial tendency to participate in the study, as well as the participants' motivation to improve their reading rates. Several participants admitted that they avoided reading because they were aware that they read at a slower pace than their peers and needed to be encouraged to overcome their discomfort with reading orally. However, the self-perception of four of the five participants had improved at the conclusion of the study. Additional stress factors (conflicts with peers and teachers) that were not related to the study may have had an impact on the one student whose attitude did not improve. All five students reported feeling less stressed about having to read aloud. Scheduled routine opportunities to read aloud may have been one factor

that helped eliminate their negative self-perceptions.

Although this study did not aim to demonstrate progress with initial reading rates, all five participants showed a trend toward improvement in initial wpm reading rates across the phases (as shown by the linear trend lines in Figures 1–5). The data indicated progress with initial readings in the final phase, ranging from 7% to 37% above the baseline initial reading rates, resulting in a mean improvement in initial reading rates of 20%. This progress may be related to three factors: more opportunities to read, overall improved self-perceptions, and reduced stress that the participants reported having during the final phases of the study.

Incorporating the OCR software into the repeated readings provided a purposeful instructional activity to increase the participants' independence with this access software. The repetition of the lessons allowed the students to become proficient and independent in loading the program, loading a preference file, locating specific data files, and using general reading commands.

By using OCR software as part of an intervention strategy to increase reading rates, this assistive technology tool became more than an accommodation and was used to remediate the participants' skills. The results of the study indicate that OCR software may be successfully used as a learning tool, not just as a substitute for printed or brailled materials.

Furthermore, all five participants found this software to be a motivation to participate, as well as a constructive component for improving their reading rates. In addition, after paired readings with the OCR software, they were able to identify independently specific words that they had read incorrectly during the initial reading.

A significant limitation of this study was the length of time in which data were collected. The validity of the interventions would have been strengthened if data could have been collected over a full school year. In addition, scheduling the 30-minute sessions, while still addressing the participants, existing needs, was difficult. Extending the study to include a maintenance phase, as was possible in Layton and Koenig's (1998) study, would have further supported the conclusions. Additional studies are necessary to confirm the conclusion that incorporating assistive technology can help improve students' independence and attitudes toward reading.

Low reading rates affect students' performance and can result in greater frustration and less time spent reading (Carver, 1990). Students with visual impairments frequently exhibit reading rates that are lower than their sighted peers (Corn et al, 2002). Teachers often accommodate their students' lower reading rates by reducing assignments or providing auditory alternatives. This study further supports the conclusion that the repeated-reading strategy can improve the reading rates of students with visual impairments. The

unique contribution of this study is evidence of the positive impact that pairing this strategy with OCR software had on reading rates and students' attitudes. Reading fluency is an area of instruction that vision teachers need to address to go beyond accommodating and to move toward resolving.

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