The Effectiveness of *Rainbow Reading:* An Audio-Assisted Reading Program

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Summary written August 2002

INTRODUCTION

This report describes research undertaken to examine the effectiveness of the audio-assisted Rainbow Reading program in improving the reading skills of struggling readers, including English Language Learners, at elementary and middle school levels.

Rainbow Reading is an audio-assisted reading program developed in New Zealand by Meryl-Lynn Pluck for students who are reading below their chronological age (Pluck, 1995). The program was developed and trialed in 1993 and has been available commercially in New Zealand since 1995. It is now used by struggling readers in over sixty percent of all elementary, middle, and high schools in New Zealand. The program has also been adapted for use in Australia, the United Kingdom, Sweden, and most recently, the United States.

The Rainbow Reading program has more than one hundred fiction and nonfiction student titles at six levels from a reading age of 6–7 years to a reading age of 11–12 years. Each book is accompanied by an audiotape of the text read by a fluent adult reader. Text-related activities also accompany each student title including cloze, text-sequencing, word search and writing activities, as well as a board game. The program comes with a teachers' guide and video to assist implementation.

Students work with the books and audiotapes individually at their instructional reading level. After a story has been oriented to them by a tutor, the student reads the text while listening to the audiotape. They do this as many times as needed in order to be able to read the story well without the assistance of the audiotape. Their reading practice may be followed by a variety of text-related activities. Students practice reading the text alone, then conference with their teacher or tutor. Students move up a level when they can read books at their current level easily, fluently, and with a good understanding.

Rainbow Reading was originally designed to accelerate the progress of struggling readers. While it is frequently used that way, it can also be used with ELL and special needs students as well as with students who are making 'normal' progress. The program is easy to operate and can be used by teacher-aides or paraprofessionals as well as teachers.

RESEARCH DESIGN

The research questions were:

1. How much progress in reading age do 29 struggling readers make when they use the audio-assisted Rainbow Reading program for 18 weeks?

2. Do the benefits of the program transfer to writing, spelling, and oral language skills?
3. Are there differences in the progress made by ELL and non-ELL students when using the program?

A simple pre-test, intervention, post-test design was used. The research was undertaken during terms 3 and 4 of 2001.

Sample

The students who participated in the study were from eight schools in Auckland, New Zealand's largest city. The schools contained students from a variety of socio-economic and ethnic backgrounds. Six of the schools were elementary and two were middle schools.

Each school was asked to nominate students who were approximately two years behind their age cohort in reading. Thirty students were needed for the research sample from grades 2–7 since these are the grades the program is designed to target. Students who spoke English as their first language made up half of the sample while new learners of English (who spoke another first language) comprised the other half of the sample. The final sample comprised 29 students (due to one student leaving the school half way through the research), including 14 ELL students as shown in Table 1 below.

Table 1

Grade level	**Number of students**	
	Non-ELL	***ELL***
Gr. 2	5	5
Gr. 3–5	5	5
Gr. 6–7	5	4

At the start of the study, the mean chronological age for all students was 9 years 6 months, with a range from 7 years 2 months to 12 years 2 months. The ELL students came from a variety of countries: Bulgaria, Macedonia, Russia, Korea (3), Indonesia, Samoa (4), India, and Tonga (2). Most of the ELL students had taken part in special programs to assist their English language learning.

Measures

Various measures were used to assess the students before they began the intervention. Each of these measures was used again after the students had been using the Rainbow Reading program for an average of 18 weeks.
The administration of all the pre-test and post-test measures was carried out by the researcher, except for the measure of reading level which was undertaken by each student's classroom teacher. The students' pre-test scores on each of these measures are given in Table 3 on page 7.

Reading level

The reading level of the students was assessed by their classroom teacher using the procedures included in the Rainbow Reading teacher's guide. The teachers tested students on sample passages from the Rainbow Reading books, which are graded into six reading age levels using the Noun Frequency Method (Elley & Croft, 1989).

The criterion used to determine the child's reading level was the highest level at which they could read unseen text with an instructional accuracy of 90–94 percent. The students' pre-test levels ranged from 6.5 to 10.5 years, with a mean of 7.4 years. This was approximately two years below the students' mean chronological age of 9.5 years.

Word recognition

Word recognition was tested using the Burt Word Reading Test (1981), a test widely used by New Zealand teachers. The students read a series of graded words in isolation, from words at age 5 level to words at age 16 level, with 10 carefully chosen words at each age level. The pre-test scores for the students in the sample ranged from an equivalent age of 6.5 years to one of 10.7 years. Their mean reading age on the word recognition test prior to the intervention was 7.68 years, nearly two years below their mean chronological age of 9.5 years.

Reading accuracy and reading comprehension

Reading accuracy and reading comprehension were assessed using the Neale Analysis of Reading Ability (1999), an individually administered prose reading test. The students read a series of graded passages aloud to the tester and respond orally to comprehension questions about each passage. They are assessed on their reading accuracy (the number of words read aloud correctly) and comprehension (the number of questions answered correctly).

In reading accuracy, the students' pre-test scores ranged from 6.3 to 9.5 years with a mean score of 7.37 years. In reading comprehension, the students' scores ranged from 6 to 12.2 years, with a mean of 7.39 years. Thus, the mean pre-test scores of the students on these measures were more than 2 years below their mean chronological age.

As would be expected, further analysis using scatterplots showed a close level of agreement between the students' pre-test scores on reading age and the students' pre-test scores on the word recognition test and the tests of reading accuracy and reading comprehension.

The pre-test scores on these measures meant that half the sample (14 students) began the Rainbow Reading program at the 6–7 year age level, with most of the remainder at either the 7–8 or 8–9 year age levels.

Spelling

The students' spelling was tested using the Peters spelling test (Peters, 1970). The test consists of 67 words that cover a range of difficulty from 5 to 15 years. The students write down the words as they are dictated to them. The test ends when 10 consecutive errors have occurred. For the purposes of this study, students' raw scores have been converted to a spelling age to provide an indication of change over time. The pre-test spelling scores ranged from 6.1 to 11.6 years, with a mean of 7.86 years.

Writing

The students' writing was assessed using a test specifically designed for the purposes of the study. They were given 10 minutes to retell 'in writing' a very short story that had been read to them immediately beforehand. The number of words the students wrote and the time taken were recorded. Different stories were used in the pre-test and the post-test to minimize any practice effects. The scores were not converted to a spelling age and are given as raw scores in Table 3. The pre-test scores ranged from 9 to 72 words, with a mean of 41.8 words.

Test of oral English language skills

As half of the sample were English language learners, the students' ability to retain and reproduce language structures, vocabulary, and sequence in English language were assessed using the van Nees test (van Nees, 1999). Ten sentences of increasing complexity were read aloud to each student, and they were asked to repeat each one. The pre-test scores ranged from 4 to 10, with a mean of 6.41 out of 10. There are no norms, but the test developer states that most eight-year-olds without a language disability and who speak English as their first language are able to gain a perfect score of 10.

Teachers' ratings of students' literacy skills

The teachers were asked to rate their perceptions of each of the sample students' literacy on the following five-point scale:
5- Handles all expected reading and writing tasks with ease.
4- Reading and writing tasks fairly well done.
3- Works conscientiously and is reasonably successful on reading and wiring tasks.
2- Makes an attempt at reading and writing tasks, but is not very successful.
1- Avoids all reading and writing tasks, or is almost unable to make an attempt.

The pre-test mean was 2.3, with a range from 1 to 3.

At the conclusion of the intervention, the teachers were also asked to rate their perceptions of the improvement their students made while using the Rainbow Reading program. We report their findings in the results section.

Student attitudes

The students in the study were asked to respond to six questions designed to check their attitude to reading in different situations (such as reading aloud) by ticking one of three faces graded from happy to sad. The students could indicate feeling somewhere between two adjacent faces – thus, a 5-point rating scale was developed and scored accordingly, with 5 for happy and 1 for sad. Each student received a score out of a possible 30. The pre-test mean was 23.66, with a range from 14 to 30.

THE INTERVENTION

During the intervention phase of the research, schools could organize the delivery of the Rainbow Reading program in any way they chose – on condition that their procedures were in accordance with the developer's recommendations. Students were to undertake at least four sessions a week of Rainbow Reading. In five schools, teacher aides or paraprofessionals worked with the students but were supported by trained teachers. In the remaining three schools, trained teachers worked with the students.

Five schools withdrew students from their classrooms for 30 minute sessions of Rainbow Reading. One school had teacher aides visiting the classrooms and withdrawing the students for 10-minute sessions, during which time they conferenced with students, introduced new books, and ensured that the students' handbooks were up to date. The students in this school also took their tapes and books home to work on. The two middle schools withdrew their students once a week for conferencing and introducing new books. These students were otherwise expected to work on the tapes and books during the times to be allocated in their classrooms. During term four, one of these schools changed to a daily 30-minute withdrawal program run by teacher aides.

The students worked individually with a book at their instructional reading level. After their teacher or tutor had oriented a book to them, the students read the text silently while listening through headphones to the taped version of the story read by a fluent adult reader. The students read the same book approximately six to eight times, or as often as needed until they could read the story without the assistance of the audiotape. They then practiced reading the text aloud on their own and conferenced with their tutor. The students also undertook a number of activities related to the text of the story they were reading. When the teacher or tutor was satisfied that the student could read the story fluently and with good comprehension, he or she was given another book to read at the same level. The students were moved up a reading level when the teacher or tutor judged that they were ready to handle more difficult text.

The Student Handbook included in the Rainbow Reading program was kept by each student as a record of their work on the program including books read, levels reached, dates of when and how many times books were read, and conference records. These records, along with the teachers' attendance registers, provided the information for describing the program that the students actually received (referred to as "the received program" in this report) as opposed to what was scheduled or planned (referred to as "the planned program").

The researcher visited each school fortnightly to collect this data and observe the program in action. As much as possible, the researcher's role was one of non-interference in the running of the program.

RESULTS

The report begins by describing the number of Rainbow Reading sessions the students actually received, as opposed to the planned sessions (as explained above). The report then describes the results on the various measures used to assess the students' progress.

Difference between sessions planned and sessions received

Although the teachers who participated in the study agreed to cooperate as best they could, the daily circumstances of the schools meant they were sometimes unable to implement the program as planned.

Table 2 (columns 1 and 2) shows that the number of sessions the students received compared with the number of sessions planned. The mean number of planned sessions in the 18-week intervention was 72.97 while the mean number of sessions actually received was 22 sessions lower at 50.45 sessions. Table 2 also shows notable differences between the mean number of sessions received by the students in the different grade levels. Grade 2 students received the highest number of sessions, and grade 6 and 7 students received 23 fewer sessions on average.

Table 2 (column 3) shows that the average number of weeks the students spent on the program was 18 weeks. The majority of students spent 16–20 weeks on the program. The average number of books read, as shown in column 4, was approximately 20. The average number of times each book was read, as shown in column 5, was approximately six (5.8). There was little difference between the numbers for ELL and non-ELL students. However, there were differences between the students at different grade levels. The older students in grades 6 and 7 had fewer sessions on average (36.78) and, consequently, read fewer books (17.11).

Table 2:
Details of the Intervention Program the Students Received

	1 Number of sessions received	2 Number of sessions planned	3 Number of weeks	4 Number of books	5 Mean readings per book	6 Total readings
Mean	50.45	72.97	18.24	20.28	5.80	119.07
S.D.	16.15	15.88	3.97	6.63	2.17	59.22
Range	25-80	32-96	8-26	10-32	3-12.9	36-293
Mean non-ELL	47.00	73.87	17.40	19.67	6.71	116.40
Mean ELL	54.14	72.00	19.14	20.93	4.82	121.93
Mean Gr. 2	59.80	70.80	17.70	22.00	6.72	142.90
Mean Gr. 3–5	53.40	72.00	18.00	21.40	5.83	128.80
Mean Gr. 6–7	36.78	76.44	19.11	17.11	4.73	81.78

Measures of student progress

Table 3 presents the pre-and post-test data on all the reading and language measures. The data shows that consistent gains were made by the students on all measures of literacy. In 18 weeks (four and a half months) using the Rainbow Reading program, the students' reading age scores increased from a mean of 7.4 years to a mean of 9.57 years. This gain represents a growth of 2 years and 2 months in 18 weeks.

Table 3:
Pre- and Post-test Scores for the Main Sample and for Non-ELL and ELL students (given in age equivalents)

	Reading Level		Word Recognition		Reading Accuracy		Reading Comp.		Spelling		Writing No. Words		Oral Language	
	Pre	***Post***	***Pre***	***Post***	***Pre***	***Post***	***Pre***	***Post***	***Pre***	***Post***	***Pre***	***Post***	***Pre***	***Post***
Mean	7.40	9.57	7.68	8.56	7.37	7.91	7.39	7.87	7.86	8.7	41.8	74.1	6.41	7.85
S.D.	1.08	1.44	1.02	1.63	0.83	1.13	1.42	1.12	1.37	1.85	16.3	27.6	2.21	2.14
Mean non-ELL	7.50	9.83	7.74	8.35	7.5	7.88	7.93	8.18	8.04	8.56	42.5	71.4	7.14	8.71
Mean ELL	7.29	9.50	7.62	8.78	7.24	7.95	6.80	7.51	7.61	9.00	41.0	77.1	5.62	6.92

In order to test this gain for significance, the obtained post-test mean (expressed in year equivalents) was compared with the pre-test mean (also expressed in years). The pre-test mean was increased by four and a half months to allow for the growth that could be expected to occur during the period of the intervention. Of course many of these low-progress students would not have made normal progress, so this adjustment is probably overly optimistic and would thus make it harder to demonstrate significant growth.

A one-tailed t test for correlated samples was applied, contrasting the post-test mean (9.57 years) with the adjusted pre-test mean (7.78) for the students. This calculation yielded a highly significant difference: $t\ (df\ 28) = 8.95\ (p < 0.01)$. Clearly the students made substantial progress in their reading level – an achievement that the Rainbow Reading program is specifically designed to foster.

We also wanted to investigate the extent to which the gains in reading levels were reflected in, or transferred to, other measures of reading and language. T tests were carried out on all the tests shown in Table 3. In each case, the same procedure as that outlined above was followed. The obtained pre-test means were increased by 4.5 months and contrasted with the post-test means. Table 4 shows the results of each of these t tests.

Table 4:
Mean Gains and t Tests on Reading and Language Measures (given in year equivalents) (df = 28)

	Reading Level	Word Recognition	Reading Accuracy	Reading Comprehension	Spelling	Writing No. words	Oral Language
Mean Gain	2.17	0.88	0.54	0.43	0.90	32.4	1.44
Adjusted Gain	1.79	0.53	0.21	0.10	0.57	–	–
t value	8.95	3.67	2.10	0.91	2.85	6.37	1.87
p. <	0.01	0.01	0.05	NS.	0.01	0.01	0.05

While the gains reported on the measures shown in Table 4 are not as great as those found for the reading levels, it is clear that the students who participated in the project made significant gains in many areas. On the word recognition test, the students gained nearly one year of growth: t (df 28) = 3.67, $p < 0.01$. The gains were also significant in the case of reading accuracy: t (df 28) = 2.10, $p< 0.05$ but not for reading comprehension: t (df 28) = 0.91, N.S. As we noted above, the comprehension score of this test is controlled by the student's performance on the accuracy sub-test, so those students who are stronger in comprehension than in accuracy may have their ability underestimated in this sub-test.

The spelling test also showed a significant gain, after adjusting for the time lapse: t (df 28) = 2.85, $p < 0.01$. The gain in the amount of writing done was substantial: t (df 28) = 6.37, $p < 0.01$, but this figure was overestimated because it was not possible to allow for the amount of time that elapsed during the intervention. Nevertheless, it is clearly large enough to suggest that gains do occur, not only in several reading skills, but also in writing fluency.

The students' scores on the oral English language test also showed a significant improvement following the intervention. However, in the absence of age norms, no accurate adjustment could be made for the time lapse: t (df 28) = 2.53, $p < 0.01$.

Correlation between gains and number of books read

One assumption of an audio-assisted reading program is that students will progress in reading if they are exposed to more books. Indeed, there is research to show that students who read more gain more in reading skill (Clay,1993).

We predicted that the students who read the largest number of books in the Rainbow Reading program would make the largest gains in their reading levels. Using the students' own records of the number of books they had read, we analyzed the correlation between these numbers and the students' gains in reading level throughout the study. The resulting correlation coefficient was r (df 28) = 0.55, $p. < 0.01$. The five students who had read at least 28 books showed gains of 3 to 5 levels, well above the mean for the total group (2.17). Meanwhile, the six students who showed the least gain (0–1 level) read an average of only 14 books. While we cannot rule out other explanations, this correlation does support the assumption that increased exposure to text is helpful for struggling readers.

Further analyses conducted on the level of gain in relation to such variables as the number of sessions, the number of readings, and the extent to which student's reading age was below their chronological age failed to show any significant patterns or correlations.

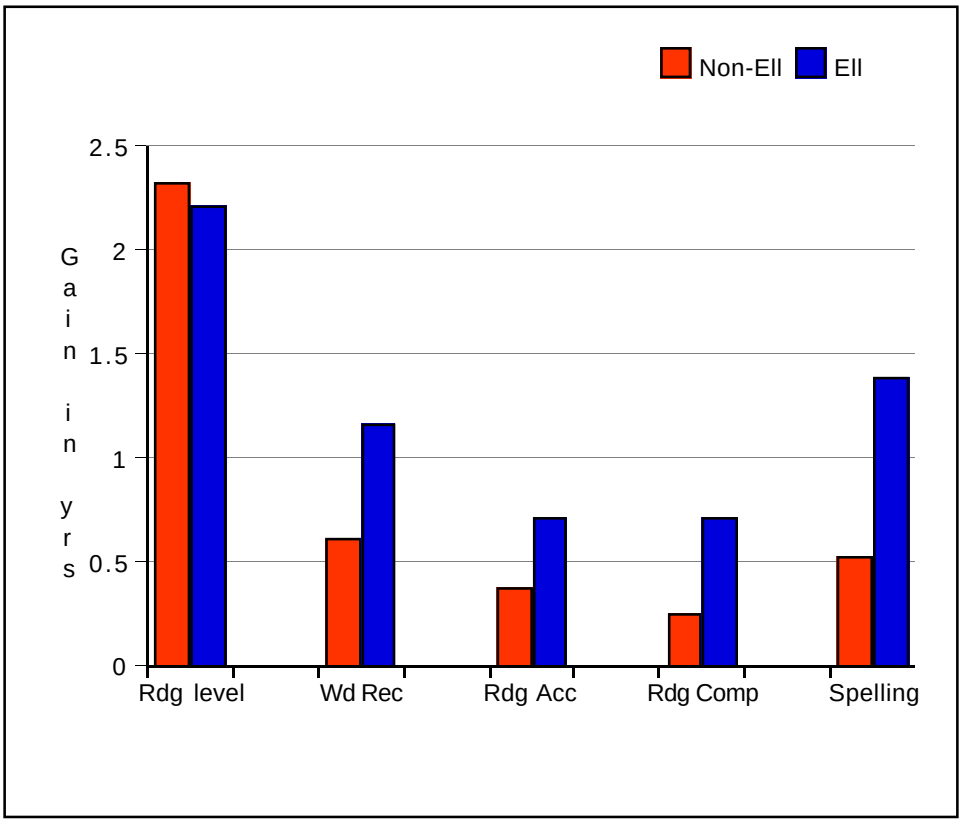
Comparison between ELL and non-ELL students

We were also interested to see if there were differences in the progress made by ELL students compared with non-ELL students on the Rainbow Reading program.

Table 3 shows that the ELL students had slightly lower pre-test mean scores than the non-ELL students, but their post-test mean scores were slightly higher on most of the measures. The ELL students therefore made more progress than the non-ELL students on all measures except for reading age, where the progress was similar between the two groups.

On the measures of reading comprehension and spelling, the rate of progress for the ELL students was more than twice that of the non-ELL students. For the measures of word recognition and reading accuracy, the rate of progress for the ELL students was almost twice that of the non-ELL students (1.90 and 1.86 times the non-ELL gains). Table 5 illustrates these differences.

Table 5:
Comparison of Gains by Non-ELL and ELL Students on Five Literacy Measures



Other measures of student progress

Teacher ratings of students' classroom performance: Teachers were asked to rate their students' classroom performance prior to and following the intervention on a five point scale. Comparison of pre-test and post-test means showed an improvement from 2.3 to 2.9. When asked to comment on the areas where they noticed improvement, the teachers commented on their students' increased enjoyment, improved reading, improved fluency and comprehension, improved reading of classroom texts, greater confidence, and willingness to attempt reading tasks.

Student attitudes: Students were asked to respond to a series of verbal questions about their attitudes toward reading. A five point rating scale was developed with 5 for happy and 1 for sad. Each student received a score out of a possible 30. The students' attitudes were generally good before the intervention (pre-test mean was 23.66 out of 30) and improved slightly after the intervention (post-test mean was 24.59). All of the students said they thought the Rainbow Reading program had helped them to improve their reading. Many said their ability to enjoy reading had improved and they were able to read more difficult books than before the intervention. Some of the students said they were able to read more difficult words as a result of being on the program.

While these findings may well have been influenced by subjective factors and have limited validity, they are clearly consistent with the view that students found the intervention helpful in a variety of ways in addition to their achievements.

DISCUSSION

The results of this research confirm that the Rainbow Reading program can significantly improve the literacy skills of struggling readers in grades 2 to 7. The data shows that consistent gains were made by the students on all measures of literacy. In 18 weeks (four and a half months) using the Rainbow Reading program, the students' reading age scores increased from a mean of 7.4 years to a mean of 9.57 years. This gain represents a growth of 2 years and 2 months in 18 weeks.

The research has also shown Rainbow Reading to be an effective intervention for ELL students. ELL students on the program made approximately twice the progress of the non-ELL students on most measures of reading.

The first aim of this research was to measure the progress made by a group of 29 struggling readers when they used the audio-assisted Rainbow Reading program for 18 weeks. Under normal circumstances, students reading two years below their chronological age would be expected to make little progress over an 18-week period. The students in this study made statistically significant progress in reading age, word recognition, and reading accuracy. The gains in reading comprehension were also statistically significant. However, when we allowed for the 18-week time lapse between the pre- and post-test, the gains in reading comprehension did not represent an accelerated rate of progress.

The second aim of the research was to examine whether the benefits of the Rainbow Reading program transferred to writing, spelling, and oral language skills. Statistically

significant gains in the amount of writing, spelling skills, and oral language skills of the students were found. We can conclude that the improvements in reading age scores made by the students using the Rainbow Reading program transferred to other language skills.

The third research question compared the differences between the progress made by ELL and non-ELL students on the program. ELL students appeared to benefit as much as, and in many cases more than, those students who spoke English as their first language.

Teachers and students also expressed positive attitudes towards the program, and the students said that the program had increased their enjoyment of reading.

Some might claim that a “practice effect” could account for some of the gains students made. However, it should be pointed out that in most cases, an alternate form of the test was used by the researcher or teacher for the post-testing so that the students were responding to different questions. In the case of the word recognition and spelling tests that had no alternate forms, it is difficult to see how the students have benefited from taking the pre-test as no feedback was given to them. Moreover, the 18-week gap meant that the students would be unlikely to remember much of the content of the tests. The only variable where a practice effect may have operated was the oral language test as there was no parallel form available, and it is possible that some of the students may have recalled some of the sentences they were asked to repeat.

The level of progress made by the students after using the Rainbow Reading program is likely to have been considerably greater than that normally made by these students given that they were approximately two years behind their classmates in reading level. The adjustment of the pre-test mean to allow for an 18-week level of progress during the intervention can therefore be considered a very optimistic assumption, and it probably reduced the levels of significance found. Furthermore, in many cases, the program was not administered as planned, and students received fewer sessions than they would have received under ideal conditions. On average, the students received 22 fewer sessions than were planned. Therefore, we predict that under ideal conditions, the level of impact might well have been greater. This conclusion is supported by the finding that the students who read the most books in the program showed the greatest gains ($r = 0.55$).

In conclusion, it is important to note that the aim of struggling reader interventions, like Rainbow Reading, should be the prevention of reading difficulty, not remediation once students have fallen notably behind their peers. It is therefore recommended that students are introduced to the Rainbow Reading program as early as possible since early intervention is likely to reduce the amount of intervention needed overall. The Rainbow Reading program can also help to identify which students need additional interventions.

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Acknowledgements: The author would like to thank Professor Warwick Elley for supervising the research and for providing assistance in the analysis of the data and the writing of this report.