Improved Reading Achievement by Students in the Craven County Schools who used Scientific Learning® Products: 2009 - 2011

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ABSTRACT

Purpose: This study investigated the effects of the Fast ForWord products and the Reading Assistant software on the reading achievement of elementary, middle, and high school students who used the products within the curriculum in a school setting.

Results: Overall, students who used Scientific Learning products made statistically significant improvements on their reading achievement. The increases in the STAR Early Literacy test scores of the Scientific Learning participants in early elementary school were significantly greater than those of students who did not use the products (101 points versus 57 points). Additionally, the improvement in the End-of-Grade Reading and End-of-Course English I scores of the older participants was significantly higher than predicted and greater than that of non-participants. These results were first found during an analysis of students who initially used the products during the 2009-2010 school year, and were replicated for students who first used the products during the 2010-2011 school year. For both groups, the more products a student used, the greater the student's improvements.

Study Design & Participants: The design of this study was a multiple-school, two-group study using high stakes and nationally-normed assessments. Study participants were elementary, middle, and high school students in the Craven County Schools in New Bern, North Carolina.

Materials & Implementation: Following staff training on Scientific Learning products, students used the Fast ForWord products and/or Reading Assistant software during the 2009-2011 school years and had their reading achievement evaluated each spring with the End-of-Grade Reading tests and End-of-Course English I test. Students were also evaluated before and after participation with the STAR Early Literacy test, STAR Reading test, and/or Reading Progress Indicator.

Keywords: North Carolina, elementary school, middle school, high school, rural district, two-group study, Fast ForWord Language Series, Fast ForWord Literacy Series, Fast ForWord Reading Readiness, Fast ForWord Reading Levels 1 - 5, Reading Assistant, End-of-Grade Test (EOG), End-of-Course Test (EOC), STAR Early Literacy (SEL), STAR Reading (STAR), Reading Progress Indicator (RPI).

INTRODUCTION

Numerous research studies have shown that cognitive and oral language skills are under-developed in struggling readers, limiting their academic progress (Lyon, 1996). University-based research studies reported the development of a computer software product that focused on learning and cognitive skills, and provided an optimal learning environment for building the memory, attention, processing and sequencing skills critical for reading success (Merzenich et al., 1996; Tallal et al., 1996). This prototype of the Fast ForWord Language software showed that

an optimal learning environment and focus on early reading and cognitive skills resulted in dramatic improvements in the auditory processing and language skills of school children who had specific language impairments (Merzenich et al,

1996; Tallal et al., 1996) or were experiencing academic reading failure (Miller et al., 1999).

Further research has demonstrated that the use of an optimal learning environment with a focus on reading and cognitive skills not only benefits the auditory processing and language skills of school children who have specific language impairments, but can benefit the reading achievement of a wide range of students.

The Craven County Schools were interested in evaluating the effectiveness of an optimal learning environment with a focus on early reading and cognitive skills as a way to improve the reading achievement of their students. In this study, commercially-available, computer-based products (Fast ForWord Language Series, Fast ForWord Literacy Series, Fast ForWord Reading Readiness, Fast ForWord Reading Levels 1 - 5, and Reading Assistant) were used to evaluate the effectiveness of this approach for improving the reading achievement of elementary, middle, and high school students.

METHODS

Participants

The Craven County Schools cover approximately 695 square miles with a total population of 94,875 residents. The district serves more than 14,000 students in fifteen elementary, five middle, and four high schools. Approximately 31% of the students in the district are African American, and 56% are Caucasian. The district encompasses several military bases, and 25% of the students are military dependents.

During the 2009-2012 school years, the use of the Fast ForWord and Reading Assistant products at 13 district schools was funded through the district's Joining Forces to Read grant. This study evaluates students who started using the products during one of the first two years. As designated in the grant, the students targeted for Fast ForWord and Reading Assistant participation included kindergarten through second-grade students identified as "at risk" on the STAR Early Literacy test and third through twelfth graders who scored at a Level 1 on the Reading EOG or English I EOC.

During the 2009-2010 school year, at the 13 schools participating in the grant, there were 7,181 students. Of these, 3,344 (47%) used the products including 45% of the students from military families and 51% of students receiving services for Special Education.

Each spring, students in 3rd through 9th grade were assessed with the End-of-Grade Tests (EOG) or End-of-Course Tests (EOC). The STAR Early Literacy test (SEL) was administered to students in kindergarten through 2nd grade and the Star Reading Test (STAR) was administered to students in 2nd and 3rd grade. School personnel administered the assessments and reported scores for analysis. EOG and EOC scores were reported from the 2009 through 2011 administrations and SEL and STAR scores were reported from the Fall and Winter of the 2009 – 2010 school year, and the Fall of 2010.

This report first analyzes EOG and EOC data to determine the impact of the Scientific Learning products on students who first used the products during the 2009-2010 school year. Using 2009 and 2010 c-scale scores, an analysis of variance (ANOVA) is used to compare the data from Scientific Learning Schools (schools with access to the products) to that of non-Scientific Learning schools (schools without access to the products) as well as to compare the data of Scientific Learning participants to that of non-participants. Finally, since most Scientific Learning participants were initially lower performing students, the performance of Level 1 and 2 Scientific Learning participants is compared to that of Level 1 and 2 students at non-Scientific Learning schools.

In a longitudinal analysis, the 2011 c-scale scores are added, comparing the change in scores (2009 – 2011) of students who first used the Scientific Learning products during the 2009-2010 school year to those of students who did not use the products at all during that time.

Finally, the 2009-2010 EOG/EOC analysis was replicated for students who first used the products during the 2010-2011 school year.

Following the EOG/EOC analysis, the SEL and STAR scores were analyzed using an ANOVA to compare the improvements of participants to those of non-participants.

Unless otherwise stated, the statistical analyses used $p < 0.05$ to define significance.

Implementation
Educators were trained in current and established neuroscience findings on how phonemic awareness and the acoustic properties of speech impact rapid development of language and reading skills; the importance of guided oral reading practice for building reading fluency; the scientific background validating the efficacy of the products; methods for assessment of potential candidates for participation; the selection of appropriate measures for testing and evaluation; effective implementation techniques; approaches for using the online reporting tool, Scientific Learning® Progress Tracker, to monitor student performance; and techniques for measuring the gains students have achieved after Fast ForWord and Reading Assistant participation.

Materials
The Fast ForWord products are computer-based products that combine an optimal learning environment with a focus on early reading and cognitive skills. Each product includes several exercises designed to build cognitive skills critical for all learning, such as attention and memory. These exercises simultaneously develop academic skills critical for reading, such as English language conventions, phonemic awareness, vocabulary, and comprehension.

Scientific Learning Reading Assistant is a computer-based tutor for guided oral reading. Combining advanced speech recognition technology with research-based interventions, Reading Assistant helps elementary and secondary students strengthen their reading fluency, vocabulary and comprehension.

Some of the primary skills developed by these products are outlined in Table 1. More detailed descriptions of the exercises and learning modes within each product can be found online at http://www.scientificlearning.com/exercises.

Primary Skills / Product Name	Listening Accuracy & Auditory Sequencing	Auditory Word Recognition	English Language Conventions	Following Directions	Listening Comprehension	Phonological Skills / Phonemic Awareness	Phonics / Word Analysis	Fluency	Vocabulary	Reading Comprehension
Fast ForWord Language	•	•	•	•		•			•	
Fast ForWord Language to Reading	•		•	•	•	•	•		•	
Fast ForWord Literacy	•	•	•	•	•	•			•	
Fast ForWord Literacy Advanced	•		•	•	•	•	•		•	
Fast ForWord Reading Readiness				•		•	•			
Fast ForWord Reading Level 1					•	•	•	•	•	•
Fast ForWord Reading Level 2					•	•	•	•	•	•
Fast ForWord Reading Level 3						•	•	•	•	•
Fast ForWord Reading Level 4						•	•	•	•	•
Fast ForWord Reading Level 5						•	•	•	•	•
Reading Assistant								•	•	•

Table 1: The Fast ForWord and Reading Assistant products work on numerous cognitive and early reading skills. The primary skills focused on by each product are noted in the table.

Assessments
Each spring, Craven County students in 3rd – 9th grade are evaluated with the North Carolina End-of-Grade Test (EOG) or End-of-Course test (EOC). Younger students are evaluated throughout the year with the STAR Early Literacy (SEL) (kindergarten through 2nd grade) and STAR Reading (STAR) (2nd and 3rd grade). For the purposes of this study, EOG and EOC scores were available from 2009, 2010, and 2011. SEL and STAR scores were available from the 2009-2010 school year.

North Carolina End-of-Grade Test (EOG): End of Grade exams are North Carolina's high stakes assessment.

Administered to students in third through eighth grade, they evaluate a student's reading and math achievement.

North Carolina End-of-Course Test (EOC): End of Course exams are North Carolina's high stakes assessments for high school students. They are used to evaluate students' proficiency upon completion of various subjects including Algebra (I & II), English I, Biology, and U.S. History.

STAR Early Literacy (SEL): The STAR Early Literacy assessment is administered to students in kindergarten, first, and second grades. It evaluates students' skills in seven domains: general readiness, graphophonemic knowledge, structural analysis, vocabulary, comprehension, phonemic awareness, and phonics. Domain scores are estimates of the percentage of items within a specific domain that the student can correctly answer.

STAR Reading (STAR): The STAR Reading assessment is a computerized assessment where the difficulty level of the items is adaptive to the reading level of the students. It is appropriate for students in 1st – 12th grades. The Craven County Schools used it to evaluate students in 2nd and 3rd grade.

Scores

Scores from the EOG and EOC were reported in terms of scaled scores. These scaled scores were converted into c-scale scores which allow comparisons across ability levels and grade-levels. Analyses were conducted on both types of scores. STAR Early Literacy and STAR scores were reported in terms of scaled scores and percentages (for the STAR Early Literacy). Analyses were performed on both types of scores.

RESULTS

Participation Level

Research conducted by Scientific Learning shows a relationship between product use and the benefits of the products. Product use is composed of content completed, days of use, and adherence to the chosen protocol (participation and attendance levels). Most students in the Craven County Schools used the Fast ForWord products' 30-Minute protocols with some of the secondary schools using 40-Minute protocols. These protocols call for students to use the products for 30 or 40 minutes a day, five days per week for nine to sixteen weeks. On average, the students' Participation was 94% and their Attendance was 72%. Some students also used the Reading Assistant program.

Assessment Results

End-of-Grade Test and End-of-Course Tests (EOG and EOC): EOG or EOC scores were available from 2009 and 2010 for 4,700 students from the Craven County Schools who were promoted one grade level at the start of the 2009-2010 school year. A comparison was made between the overall performance of students at schools where products were used and students at schools where products were not used, as well as between the performance of students who used the products and the performance of their peers who did not use the products.

Of these 4,710 students, 1,799 attended nine schools where Scientific Learning products were not used (non-SLC schools) and 2,911 attended 13 schools where the products were used as part of the Joining Forces to Read grant (SLC schools). Students from two schools that used the products but were not part of the Joining Forces to Read Grant had incomplete data and were not included in the analyses.

Of the 2,911 students who attended schools in which Scientific Learning products were available, 1,921 students did not use products (non-participants) and 990 students did use products (SLC participants) (Table 2). EOG and EOC results were analyzed in terms of non-SLC schools versus SLC schools and Non-Participants versus SLC Participants.

Schools		Students	
Group	n	Group	n
Non-SLC Schools	9	Non-Participants	1799
SLC Schools	13	Participants	990
		Non-Participants	1921
Total	22	Total	4710

Table 2. The breakdown of schools and students that used Scientific Learning products.

A grade-by-grade comparison of the changes in EOG scores of Scientific Learning participants to those of students in comparable grades in schools that did not use Scientific Learning products showed that at each grade, the participants performed as well as (5th and 6th grades) or significantly better than (4th, 7th, and 8th grades) students at schools that did not use the products (Table 3; Figure 1). Scores for 9th graders are not shown due to the dramatic differences of the scales for the EOG and EOC.

	Participants		Schools w/o SLC		
Grade	N	Change	N	Change	t-statistic
4th	223	7.3	388	5.8	2.8*
5th	173	5.2	396	5.4	-0.2
6th	165	3.1	145	2.9	0.2
7th	179	5.5	150	3.9	2.5*
8th	165	4.7	149	2.6	3.8*

*Table 3. The number of students and average changes in scaled scores for students in each grade who used Scientific Learning products, and for students in comparable grades at schools that did not use the products. An unpaired t-test was used to compare the changes for the two groups. * $p < 0.05$.*

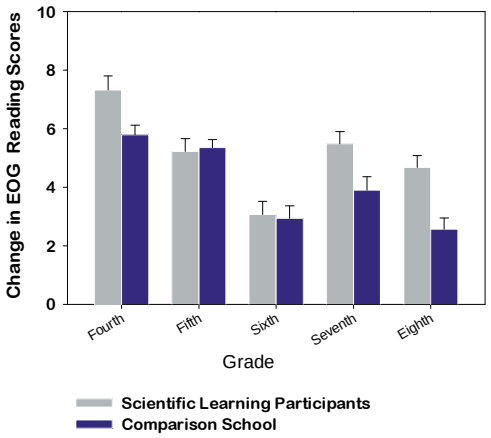

Figure 1. In general, Scientific Learning participants made greater gains than non-participants. Results shown by grade level (grade 4: n=223/388, grade 5: n=173/396, grade 6: n=165/145, grade 7: n=179/150, grade 8: n=165/149).

Analysis of EOG and EOC C-Scale Scores

In an effort to bring students up to proficiency, North Carolina educators work to improve students' performance each year, relative to their performance the prior year. Using a Growth Model, an Academic Change (Growth) score is calculated based on the student's current and prior score(s). The goal is for students to have a positive Academic Change score where:

Academic Change (Growth Score) =

(Current C-Score) – 0.82 × (Previous c-Score)

C-scores are calculated using the statewide mean and standard deviation for the student's grade level:

C-score = (Scaled Score – Mean) / Std. Deviation

The mean and standard deviation at each grade are supplied by the North Carolina State Board of Education.

Using these formulae, a student's "Predicted Score" in 2010 can be calculated from his or her 2009 score and an expected Academic Change (or Growth) of 0.

On average, Scientific Learning participants in the fourth through eighth grades (Figure 2) significantly exceeded predicted scores on the EOG Reading Test ($t(905)=2.4$, $p<0.05$) and Scientific Learning participants in ninth grade (Figure 3) exceeded predicted scores on the EOC English I Test ($t(85)=1.8$, $p<0.10$)).

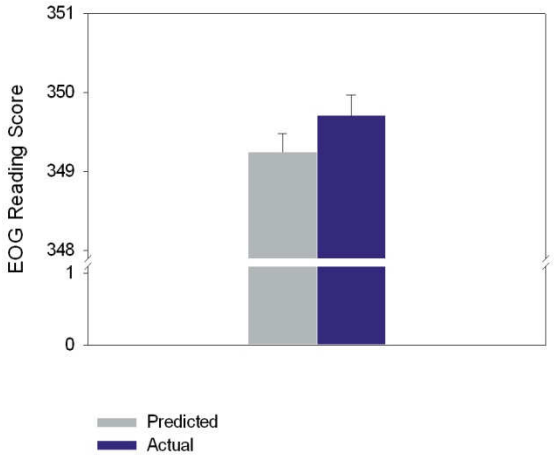

Figure 2 Fourth through eighth graders who used Scientific Learning products exceeded expected scores. Nine hundred five students are included in this graph.

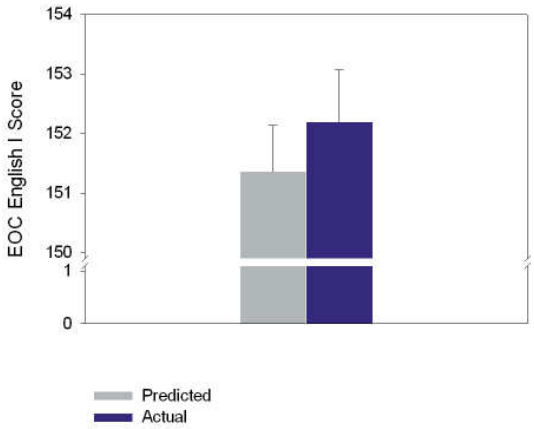

Figure 3.Ninth graders who used Scientific Learning products exceeded predicted EOC scores in 2010. Eighty-five students are included in this graph.

The following analyses consider "Growth Scores" and therefore combine the results from the EOC and EOG tests. In the first analysis, which was a comparison of all students with scores at SLC schools (regardless of whether the students had used the products) to all students with scores at

non-SLC schools, the students at the SLC schools made significantly greater gains on the EOG Reading and EOC English I tests than students at the non-SLC schools ($t(4710)=2.2$, $p<0.05$) (Figure 4).

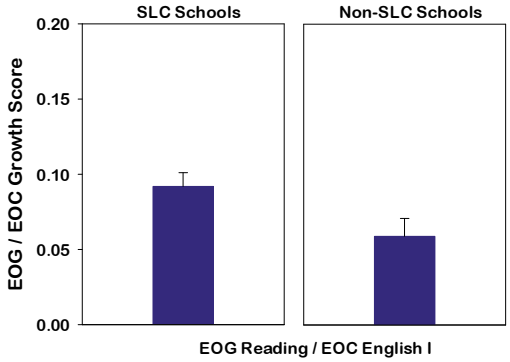

Figure 4.Students from SLC schools (n=2,911) outperformed students from non-*SLC schools (n=1,799) on the 2010 EOG and EOC.*

A follow-up analysis that focused specifically on students at the SLC Schools who had actually used the products showed an even greater difference between the two groups ($t(2789)=2.1$, $p<0.05$) (Figure 5).

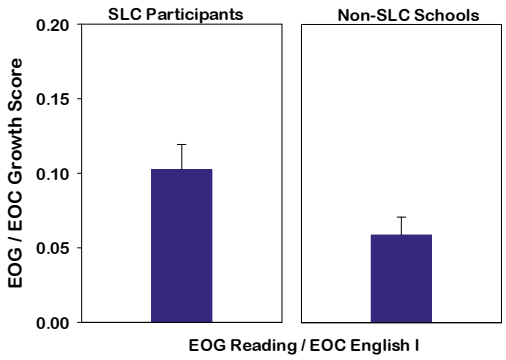

Figure 5. Scientific Learning participants (n= 990) significantly outperformed non-participants (n=1,799) on the 2010 EOG and EOC.

Results also showed that students who completed multiple Fast ForWord products achieved greater EOG Reading and EOC English I growth than students who used one Fast ForWord product (Figure 6).

<u>Level 1 and 2 Students:</u>
At the Scientific Learning schools, 78% of Level 1 and 2 students used Scientific Learning products while only 23% of Level 3 and 4 students used Scientific Learning products. The following analyses compared the growth of Level 1 and 2 Scientific Learning participants to that of (1) Level 1 and 2 students at non-SLC schools and (2) Level 1 and 2 non-participants from schools where the products were being used. EOG and EOC scores were available from 2009 and 2010 for 1,079 Level 1 and 2 students. Of these, 498 students attended non-SLC schools and 581 attended SLC schools. Of the 581 students who attended SLC schools, there were 127 non-participants and 454 SLC participants.

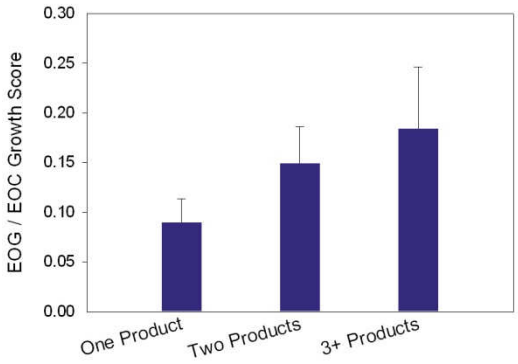

Figure 6.Students who used only one Fast ForWord product (n=495) achieved less benefit on the EOG and EOC compared to students who used two products (n=241) and three or more products (n=74).

On average, Level 1 and 2 students who attended SLC schools achieved significantly greater improvements on the EOG Reading and EOC English I tests than Level 1 and 2 students who attended non-SLC schools ($t(950)=3.2$, $p<0.01$), and, at the SLC schools, the gains of Level 1 and 2 SLC participants were greater on the EOG Reading and EOC English I tests than those of non-participants, trending towards significance ($t(581)=1.7$, $p<0.10$); see Figures 7 and 8.

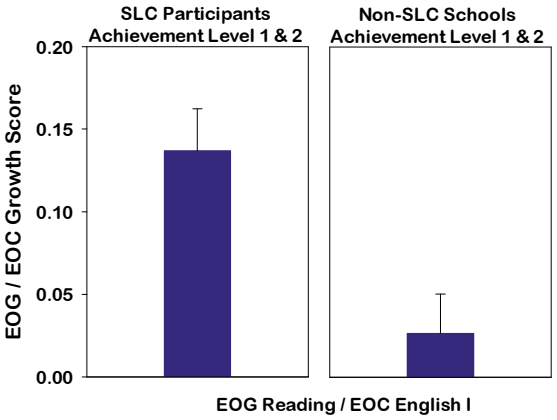

Figure 7. Level 1and 2 students from SLC schools (n= 454) significantly outperformed Level 1 and 2 students from non-SLC schools (n=498) on the 2010 EOG Reading and EOC English I Test.

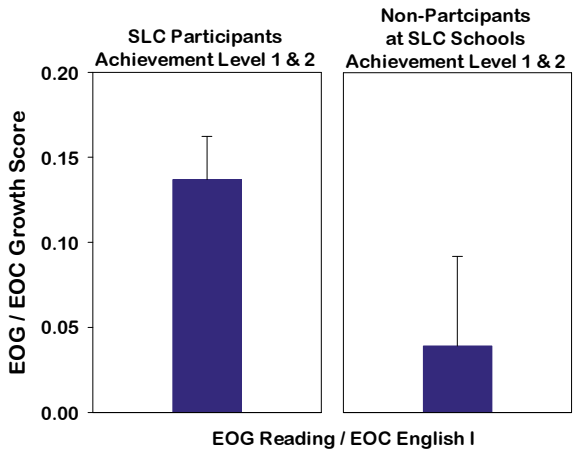

Figure 8. At schools using Scientific Learning products, Level 1 and 2 Scientific Learning participants (n= 454) outperformed Level1 and 2 non-participants (n=127) on the 2010 EOG Reading and EOC English I Test.

Longitudinal Results:

Results from 2009 through 2011 were available and used to analyze longitudinal results. Focusing on students who first used the products during the 2009 – 2010 school year, the c-scale scores of participants were compared to the c-scale scores of non-participants. (Since there were numerous students who changed schools between the 2009-2010 and 2011- 2012 school years, when the data were collected, comparisons were not made between Scientific Learning schools and non-Scientific Learning schools. Results from the two schools that used the Scientific Learning products, but not as part of the Joining Forces to Read grant were not included due to the availability of only part of the data from those schools.)

Across all levels, there were 731 students who started using the Scientific Learning products during the 2009-2010 school year and had 2009 and 2011 c-scale scores available, and there were 2,450 students who did not use the products during either the 2009-2010 or the 2010-2011 school years and had scores available (Table 4).

	N	Change in c-scale score (2009 to 2011)
Scientific Learning	731	0.274
No Scientific Learning Use	2450	0.063

Table 4. Change in c-score between 2009 and 2011 for all students with 2009 and 2011 scores.

A follow-up analysis investigated the impact on only the students who were Level 1 or 2 in 2009 (Table 5).

	N	Change in c-score (2009 to 2011)
Scientific Learning	439	0.49
No Scientific Learning Use	554	0.44

Table 5. Change in c-scale score between 2009 and 2011 for all Level 1 and Level 2 students with 2009 and 2011 scores.

A comparison of Table 4 and Table 5 indicates that the Scientific Learning participants were generally lower performing than the non-participants with 60% of the participants at Level 1 or 2 and only 23% of the non-participants at Level 1 or 2. For both groups of students, the change in c-scores of the Scientific Learning participants was greater than that of the non-participants.

The 2009 - 2011change in c-scale scores for the Level 1 and 2 students varied with the number of products students completed from 0.44 for students who only completed one product (n = 164) to 0.58 for students who completed three or more products (n = 121) (Figure 9).

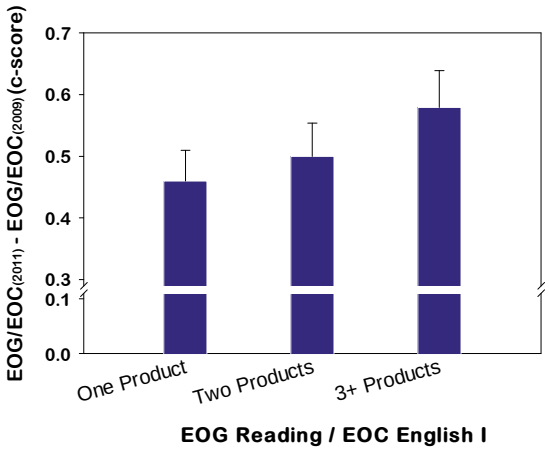

Figure 9. Change in c-score between 2009 and 2011 for Level 1 and 2 students who used the Scientific Learning products. Results include 164 students who completed one product, 116 who completed two products, and 121 who completed three or more products.

Replication of Results:

Using data from students who first used the Scientific Learning products during the 2010 – 2011 school year, the initial one-year analysis was replicated. There were 306 students with 2010 and 2011 scores who first used the Scientific Learning products during the 2010-2011 school year; 49% (n = 149) were Level 1 or Level 2 on the 2010 assessment. Of the 3,345 students with scores who

did not use the products during the 2009-2010 or 2010-2011 school years, 22% (n = 734) were Level 1 or Level 2 in 2010. The students who first used the Scientific Learning products during the 2010-2011 school year achieved a Growth Score of 0.34, significantly greater than the 0.20 Growth Score of the Level 1 and 2 students who did not use the products ($t(881) = 3.2$; $p < 0.01$) (Figure 10).

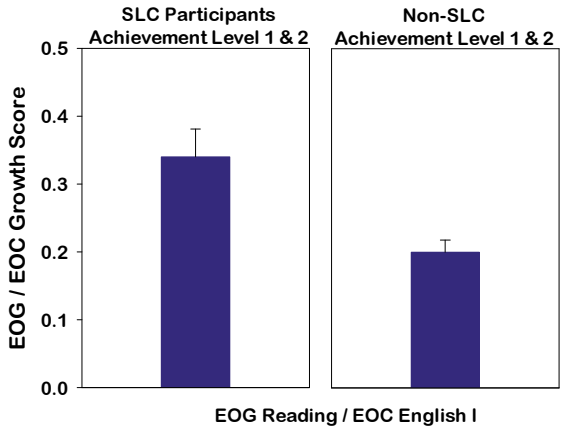

Figure 10. Level 1 and 2 Scientific Learning participants (n= 149) significantly outperformed Level1 and 2 non-participants (n=734) on the 2011 EOG Reading and EOC English I Test.

STAR Early Literacy (SEL) and STAR Reading (STAR): During the 2009-2010 school year, the SEL was administered to students in kindergarten, first and second grades while the STAR was administered to students in second and third grades. Scores from the fall, 2009 and winter, 2010 administrations were reported for analysis, as well as scores from the fall, 2010 administration. Scores were analyzed for students who started using the products between the fall, 2009 and winter, 2010 assessments. The kindergarten and first graders had scores available for analysis from the fall, 2009 and fall, 2010 administrations of the SEL, while the second graders had SEL scores available from the fall, 2009 and winter, 2010 administrations, and STAR scores available from the fall, 2009 and fall, 2010 administration..

The number of students who started the products between the fall and winter tests, and who had the appropriate SEL tests available for analysis, ranged from 237 (first graders) to 325 (kindergartners). In addition, there was a small group of 19 kindergartners who had scores available, but did not start using the products until after the fall, 2010 administration of the SEL providing a comparison group for the kindergartners. Three hundred sixty-four participants from second grade had STAR Reading scores available for analysis.

On average, students in kindergarten and first grade made statistically significant improvements on their SEL scores (Figure 11), while students in second grade made statistically significant improvements on their STAR Reading scores (Figure 12).

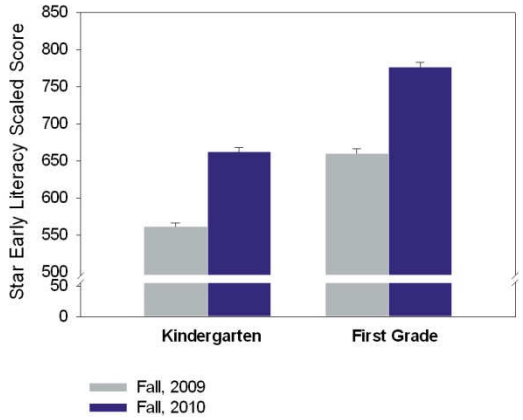

Figure 11. SEL scores from Fall, 2009 and Fall, 2010 for kindergartners and first graders who started using the products during the Fall of 2009. The results for both grades showed statistically significant improvements (kindergartners: $t(325) = 20.9$, $p < 0.01$; first graders, $t(237) = 20.3$, $p < 0.01$).

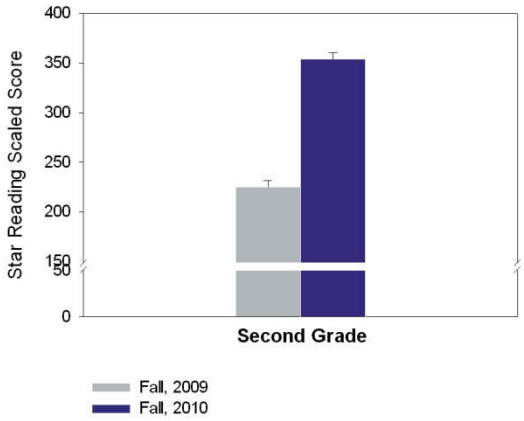

Figure 12. STAR scores from Fall, 2009 and Fall, 2010 were available for second graders who started using the products during the Fall of 2009. The results showed statistically significant improvements ($t(364) = 25.8$, $p < 0.01$).

An evaluation of the seven domains that the SEL assesses showed improvements in all areas. Paired t-tests were performed and showed that the improvements were statistically significant for both the kindergartners (Figure 13) and the first graders (Figure 14).

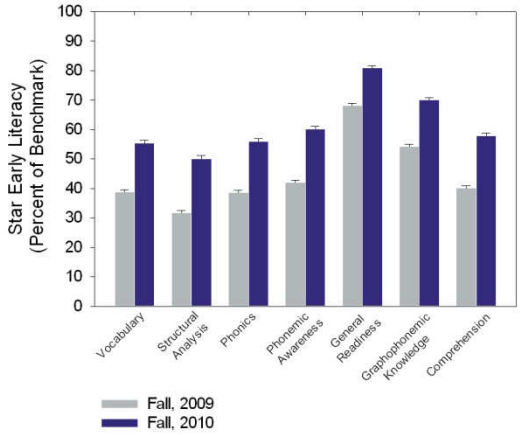

Figure 13. Kindergartens achieved statistically significant improvements in all domains (n = 325; p < 0.01).

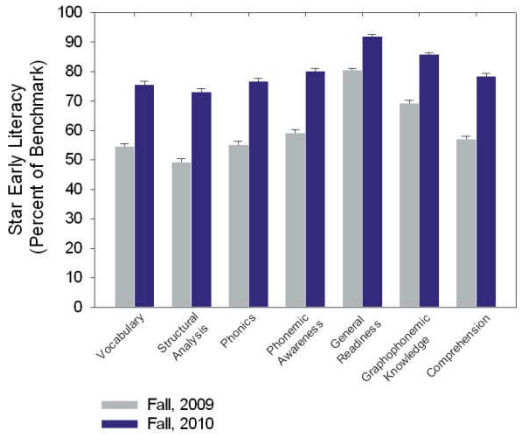

Figure 14. First graders achieved statistically significant improvements in all domains (n = 237; p < 0.01).

There were 19 kindergartners who had scores available for analysis, but did not start to use the Scientific Learning products until after the fall, 2010 assessment. Figure 15 shows that their average improvement on the SEL was 57 points while the improvement of the students who did use the Scientific Learning products was 101 points. An analysis of variance (ANOVA) was performed and showed that the improvements achieved by the students who used the Scientific Learning products were significantly greater than those of the students who did not use the products ($F(342) = 4.7$; $p < 0.05$).

DISCUSSION

This study shows that students who used the Scientific Learning products during the 2009 – 2010 school year improved more than expected (had positive growth scores) and made statistically greater improvements on their EOC and EOG scores than their peers who did not use the products. These results were replicated for a group of students who first used the Scientific Learning products during the 2010-2011 school year.

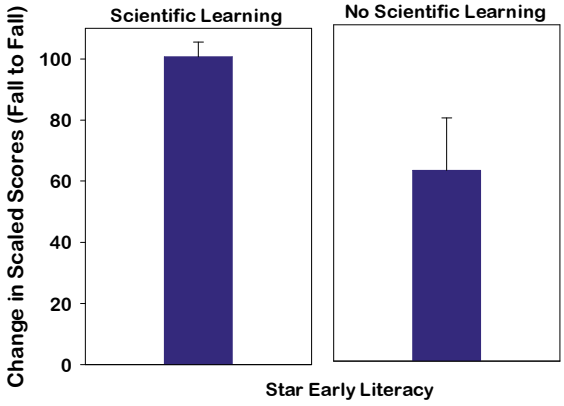

Figure 15. Kindergartens who started using Scientific Learning products during Fall, 2009 (n = 325) achieved significantly greater improvements on the SEL than kindergartners who did not use the products until after the fall, 2010 assessment (n = 19).

Further analyses showed that, on average, the more products students completed, the greater their improvements. This was true both immediately after students used the products (2009-2010), and the following year (2009 – 2011).

In addition to impacting the achievement of students in late elementary school and secondary schools, the products impacted early elementary education. Students in kindergarten through second grade made statistically significant improvements on the STAR Early Literacy or the STAR Reading tests after using the Scientific Learning products.

Many of the Scientific Learning participants were struggling, performing at low levels on the SEL test, or at an EOG Reading Level 1 or 2 in 2009. Despite the students' history of slow progress, they made statistically significant improvements in their reading achievement, exceeding expectations, and outperforming non-participants. These gains were seen across grade levels and skill levels.

These findings demonstrate that, within the Craven County Schools, an optimal learning environment coupled with a focus on cognitive and early reading skills can help students attain a higher level of reading achievement.

CONCLUSION

Cognitive and language skills are critical for all students, impacting their ability to benefit from

instruction, follow directions and participate in class discussions. Strong cognitive skills also provide a critical foundation for building language, reading, and math skills. After using Scientific Learning products, students in the Craven County Schools made significant gains in their reading skills and achievement. These results replicate other studies and suggest that using the Fast ForWord products and Reading Assistant software strengthened the students' foundational skills and better positioned them to benefit from the classroom curriculum.

Notes:

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