Live Ink®: Brain-Based Text Formatting Raises Standardized Reading Test Scores

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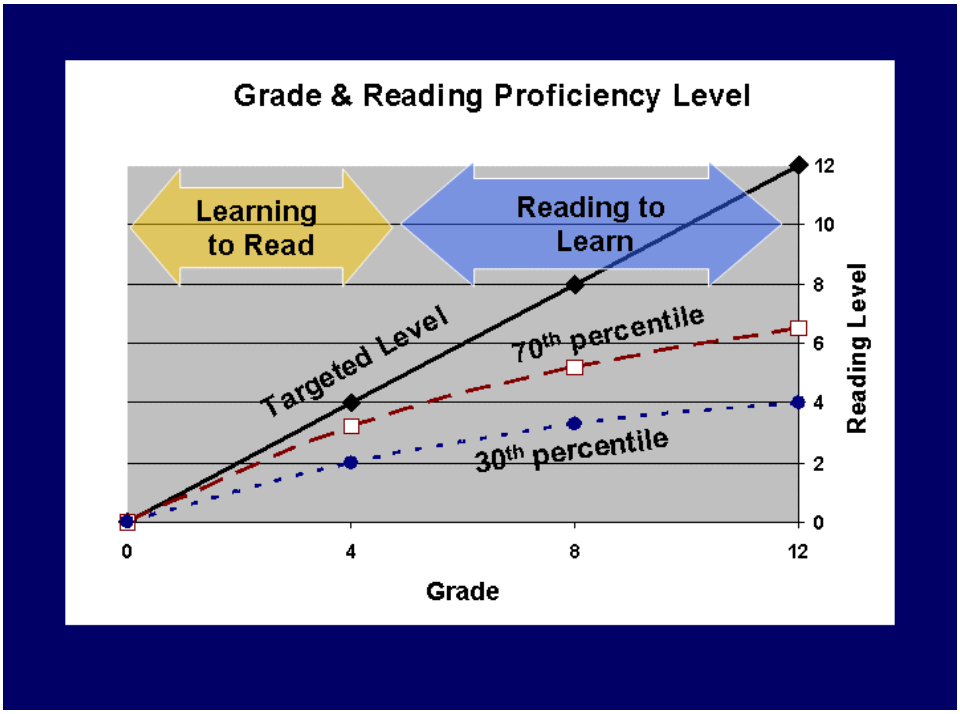
Reading Performance in the Information Economy

In today's Information Economy, over 60 percent of US jobs require proficient reading skills. Most US information workers need to read for several hours a day, (and increasingly from computer displays). (Derouzos, 1997) The economic value of wages for workers to spend time reading is therefore over $2 trillion a year. Moreover, over the past 30 years, the difficulty of reading material in US jobs has increased by several grade levels, but the reading proficiency of US students has not changed over this period. The US Department of Labor estimates that poor reading in the workplace costs US businesses over $225 billion a year, in waste, accidents, lost opportunities, and injuries. (Sum, 1999; Sum, Kirsch, & Taggart, 2002).

Although the reading material for the top 70 percent of US jobs is at a 9th grade level, 70 percent of today's high school seniors cannot read above a 7th grade reading level -- and 30 percent still read no better than a targeted 4th grade reading proficiency level. (National Center for Educational Statistics, 2003) Recently, new Federal programs have emphasized phonemic awareness in the early grades, as a keystone for building reading proficiency. However, as students move through the middle and high school years, the gap between targeted and actual reading proficiency gets wider -- suggesting that additional kinds of reading development are needed.

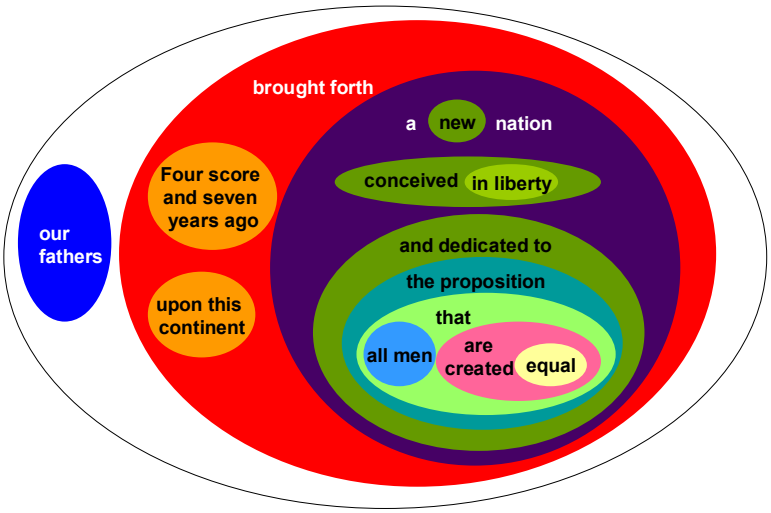


The widening gap between actual and targeted reading proficiency during middle and high school years also creates a dual dilemma for students and educators: (i) the curriculum must cover increasing amounts of specific content, leaving less time for targeted reading intervention; and (ii) the content itself is presented in larger and more complex texts to be read.

A new method of formatting electronic text, Live Ink®, applies recent advances in Cognitive Science, and harnesses the digital attributes of electronic text to help solve this important educational and economic challenge. The visual and syntactic principles of this method have been explained in detail in a recent, separate publication, (Walker, Schloss, Fletcher, Vogel & Walker, 2005) and are summarized below.

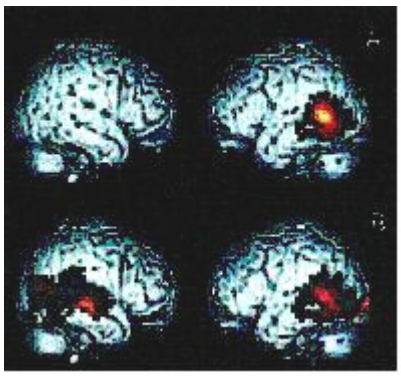
Integrating Visual and Syntactic Processing with Multidimensional Text Cues

Visual Processing. When the eyes track block text, the visual system can process only a small zone of visual data at each fixation, as shown at right. As a reader moves this "soda-straw" view across the standard page, attentional resources are strained, and the mind's eye is unable to retain phrases in visual memory. Many of the eye-movements in reading (20% or more) are actually *regressions* -- in which the reader needs to re-examine previously viewed words and re-interpret phrase and clause relations between words.



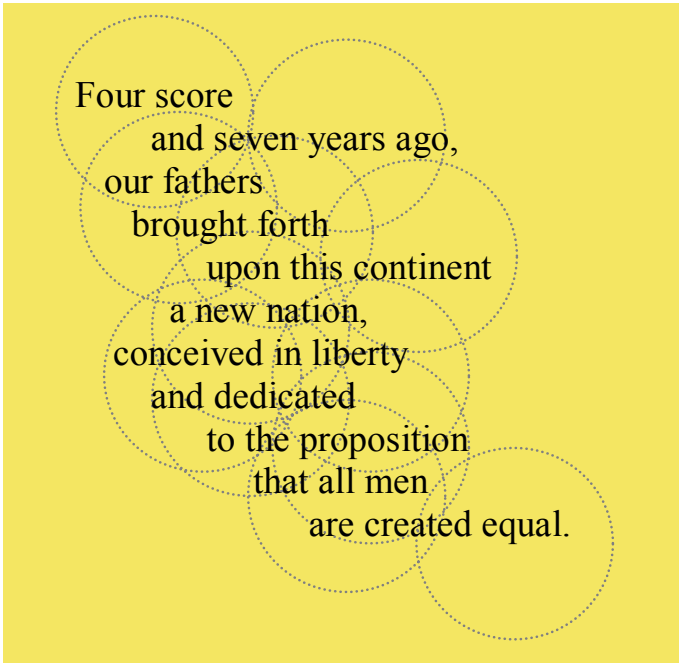
Syntactic Processing. Syntax is more complex than simply chopping a sentence into a series of phrases: it also requires identifying how phrases and clauses are *hierarchically* related, with some clauses "nested" within larger ones. Syntactic processing is a bridge between word-decoding and higher-order comprehension, and is an important factor in reading fluency. Brain studies have shown that syntactic processing also collaborates with the other steps in reading.

When a reader encounters sentences with complex syntax, the brain dynamically recruits additional cortical regions to solve the syntactic "puzzle" (as shown at right). Because of the dynamic collaboration between syntactic tasks and other comprehension tasks, assisting readers with syntactic cues can free-up other brain resources for higher-order comprehension of the subject matter.



Simple Syntax

Complex Syntax



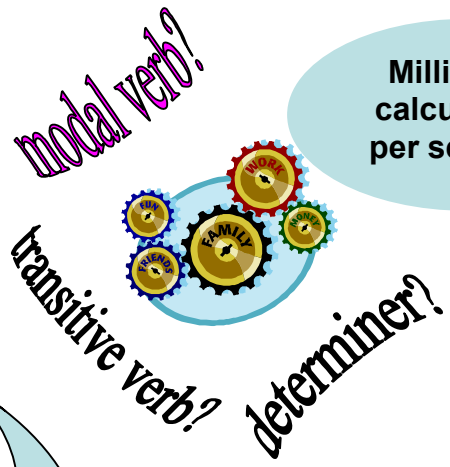
The goal of Live Ink text formatting is to help the eye and the mind work together to build meaning as one reads. This is accomplished by segmenting the text to fit into 1 to 2 fixation eye-spans; using indentation patterns that enable to reader to perceive the relative positions of adjacent rows while focusing on a particular row; and using multi-row patterns that cue syntactic structure and enhance visual memory across phrase-groups.

In this way, the brain can use its powers for pattern recognition to build sentence meaning and boost comprehension.

How Live Ink Text is Made

Live Ink's computer-based parsing engines apply algorithms that analyze each sentence -- using both visual and linguistic criteria to determine optimal positions for segment breaks and indentation patterns. Computer databases and algorithms can also highlight verbs in each sentence. Several million computer calculations are performed for each sentence in a text. Overall, Live Ink software transforms a shapeless linear text string into an integrated, multidimensional image that cues sentence structure -- dynamically supporting the reader's visual inspection, lexical processing, and interpretation of the text.

When in the Course of human events, it becomes necessary for one people to dissolve the political bands which have connected them with another, and to assume among the powers of the earth, the separate and equal station to which the Laws of Nature and of Nature's God entitle them, a decent respect to the opinions of mankind requires that they should declare the causes which impel them to the separation.



Lines *break* at phrase and clause boundaries

Shorter rows of text *fit* in 1 or 2 fixation spans

Cascading *depicts* syntactic hierarchies

Row-clusters *remain* vivid in "mind's eye"

Indentations *guide* the eyes from row to row

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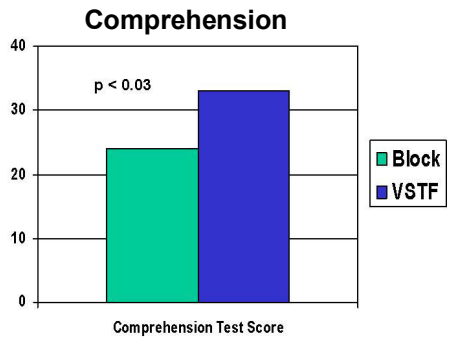
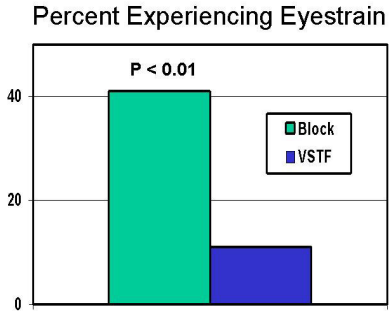
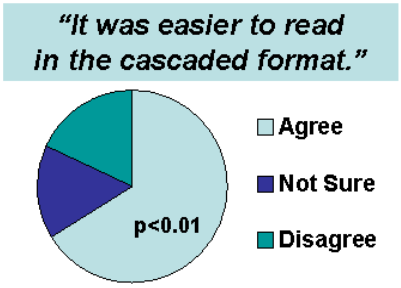
Preliminary Live Ink Validation Research

Prior research, conducted independently by two universities and involving college level readers and 9th grade high school students, has been reported elsewhere (Walker, Schloss, Fletcher, Vogel & Walker, 2005), and is summarized below; both studies used ***randomized controlled study designs***.

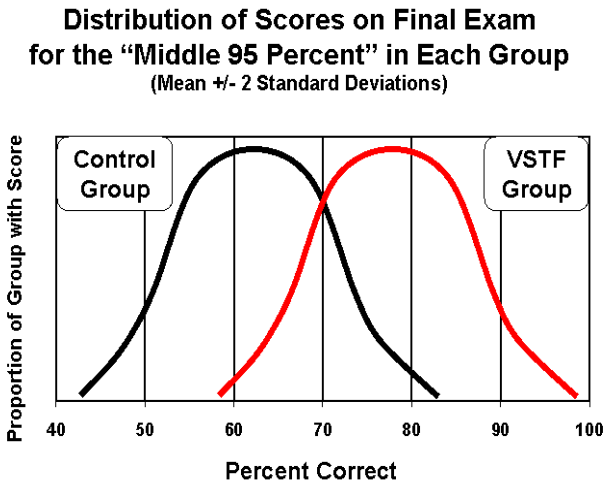
College Reader Results. Among college-level readers, studied in a "within subjects" randomized controlled design, Live Ink format significantly increased reading comprehension and reading efficiency (comprehension divided by reading time). The effect size of this increase was over one-half of a standard deviation higher for texts read in Live Ink (VSTF, for "visual syntactic text format") compared to block format. Readers also reported eyestrain symptoms much less frequently when reading Live Ink text compared to block format (a 75% reduction in the frequency of eyestrain symptoms). Over sixty percent of the readers immediately preferred the Live Ink format over block format, after only 1 hour of use.

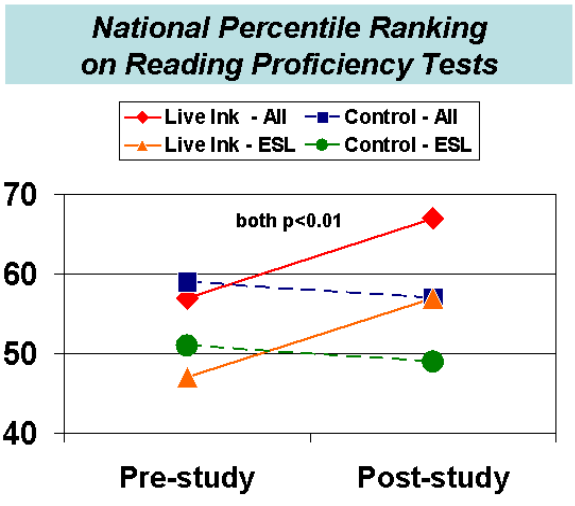






Grade 9 High School Results. In a study spanning an entire academic year, 9th grade students in the Live Ink classes had significantly higher scores on quizzes and unit exams. The difference between Live Ink and Control classes' exam scores got larger over the year. On the final examination in the spring semester (covering material from the entire semester), Live Ink classes scored more than a full-standard deviation higher than Control classes. In addition, reading proficiency tests (given in block format) showed that the Live Ink groups had become significantly better readers, gaining nearly 10 percentile points in age-adjusted national percentile rankings, while the control group remained at the same national percentile ranking. Students for whom English is a non-native language made significant gains, attaining the same reading proficiency level as the control group of native English students.





US Department of Education-funded Research

In 2001 and 2002, Live Ink received Phase 1 and 2 SBIR Innovation Research Awards from the US Department of Education. With this support, additional controlled studies were conducted to demonstrate the impact of Live Ink on learning and long-term reading proficiency, following guidelines at the US Department of Education's *What Works Clearinghouse (http://www.whatworks.ed.gov/)* for scientific educational research.

Research Sites

The sites were one high school and four middle schools, in a single rural-suburban school district in Colorado. Because this research involved the evaluation of educational interventions in a classroom setting, the research qualified for an exemption (category 1) from Federal Human Subjects research regulations. All student data were kept within school district, and analyzed exclusively by school district personnel. The research spanned the 2003-2004 academic year

Student Demographics

The proportion of students for whom English was a non-native language was approximately 35% in each grade; see table on page 14. The percentage of students qualifying for free or reduced lunch was 27.5%.

Teacher Participants

At the high school level, all three social sciences teachers participated, each teaching both a control and an intervention group in the same grade. At the two middle schools where the intervention was used, there were a total of 10 teachers, from both social sciences and language arts subject areas.

Materials and Methods

Texts and Reading Sessions. The main texts were the social sciences textbooks for each grade. In addition, at the middle school level, students also read curriculum-required narrative literature, such as passages from classic novels.

At the high school level, both VSTF and block text version of electronic textbooks were prepared. Both electronic textbook platforms permitted font enlargement, dark and light background colors, and point-&-click table of contents. Block formatting for the control groups electronic textbooks used the same number of characters per line as was found in the standard, paper-based textbook.

At the middle school level, the intervention groups used a web-based text-presentation platform for the Live Ink (VSTF) version of the text; the text manipulation capability was more limited than the high school versions, but still permitted font enlargement and color modification. Table of contents functionality was provided by a list HTLM links, which the students would use to go to selection positions in their texts. Similar chapter-by-chapter navigation was provided for classic narrative literature. Control students in the middle school level used their standard, paper-based textbooks.

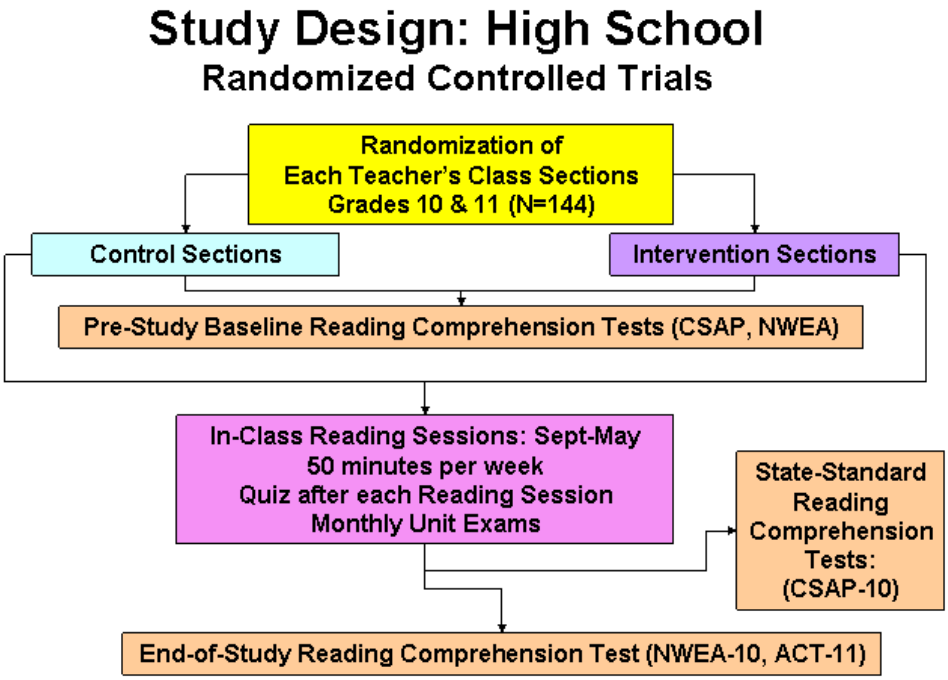
Computers. At the high school level, laptop computers using Microsoft Windows® operating system were used, and the electronic textbooks were presented in Windows-based applications that had been developed specifically for the VSTF method. Laptops were kept on a rolling cart that could be moved from classroom to classroom. If scheduling conflicts precluded laptop use, high school reading sessions could also be conducted in the school's computer labs, which used desktop PCs. At the middle school level, the Live Ink text was presented in newly developed web-based (HTML and JavaScript) software modules and read from Apple® iMacs in computer labs; these electronic texts were maintained on remote servers, outside of the district, and required district-level passwords to gain access to the content.

Study Designs

Data on intervention and control students were collected prospectively, including district and state-mandated nationally standardized reading tests that were required for all students.

High School: Randomized Controlled Trials

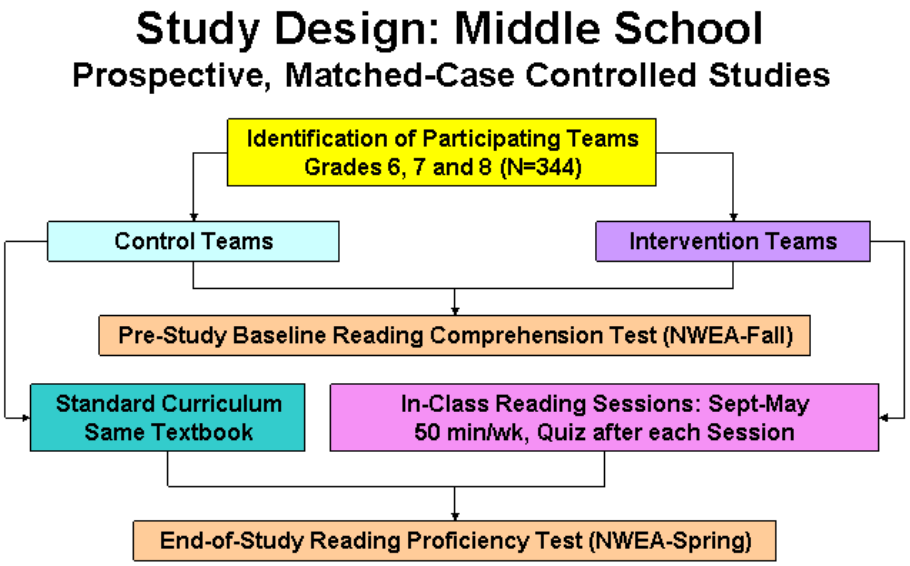
High School students were evaluated with RCTs within the same high school -- with randomization occurring at the within-teacher, class-section level. At the beginning of the 2003-2004 academic year, for each high school social sciences teacher, a grid of each teacher's class section schedule was constructed, so that an equal proportion classes, balanced according to morning and afternoon time periods, would be assigned to intervention and control groups. Such a grid would thus have an "A" set of classes and a "B" set of classes, which would be assigned, based on randomization with a coin toss, to either the intervention or the control group. The coin toss was performed by the district curriculum director, who was otherwise not involved in the study, and who had no knowledge of the composition of the classes in the grid. Baseline NWEA tests for reading proficiency were then performed for all classes.



Middle School: Prospective, Matched-Case Controlled (PMC) Studies

Middle School students were studied with prospective, matched-case controls, identifying matching intervention students from two of the middle schools with corresponding control students from the same middle school, but on a different "team", or from other middle schools in the same district using the same curriculum.

For the PMC, each student in the intervention group was paired with a student for the control group who was either in a different team in the same school or in another middle school matched for, by priority: (a) baseline scores on the Northwest Education Association's nationally standardized test for reading; (b) native English versus non-native English speaking status; and (c) gender. (Quasi-experimental Design with Equating).



Intervention Method

At each grade, students read in class for approximately 50 minutes a week. At the high school level, the teacher-supervised reading sessions, for both intervention and control groups, occurred in social sciences classes. No electronic textbook reading occurred outside of class time. Because neither the VSTF electronic textbook nor the block electronic textbook had any images or figures, students in both the intervention group and the control group were always free to open and use their standard, paper-based textbooks in class, either to complete the assigned reading section or to examine the paper textbook's figures and images.

At the middle school level, a target of 50 minutes of reading per week was accomplished by having intervention students read, in computer labs, either social sciences or language arts content. Control students received their standard curriculum, which employed the same textbook as the intervention groups. Social Sciences teachers and Language Arts teachers whose classes used the intervention were on the same "team" ; in this way, there was no crossover between control group and intervention group, and students who were receiving the intervention in social sciences classes would also be receiving the intervention from their language arts teachers.

After each social sciences reading session, students were given a 10-point quiz, from the publisher-provided section quizzes for the textbooks, which counted toward a student's grade. Because participation in the study was integrated with classroom activities, and thus controlled directly by teachers, there was not attrition, and no crossover between study groups.

Outcomes measurement

Reading Comprehension. For several years prior to the study, the school district had already adopted the Northwest Education Association (NWEA) MAP test for Reading (www.nwea.org), as a tool to assess individual student progress and to document teacher performance. For this study, for grades 6 through 8 and grade 10, both in the control groups and intervention groups, the school district's data on the NWEA test was used for both baseline, pretest, measurement of reading comprehension in the fall, and for end-of-year, posttest, measurement of reading comprehension in the spring.

Academic Achievement. For 10th and 11th grade students, it was also possible to analyze district-based data of each student's score on the Colorado Student Assessment Program (CSAP) reading section. For baseline, pretest, measurement, scores from the previous spring were used (i.e., scores from CSAP tests given in the spring of 2003, while in grade 9, were used as baseline for students in the 10th grade during the 2003-2004 academic year). Because the state of Colorado requires all 11th graders to take the ACT college placement test (whether the student plans to go to college or not), it was possible to use the district's the ACT reading section scores as a posttest measure for the 11th grade. For grades 10 and 11, it was also possible to analyze the scores of students' quizzes given after each reading session, and of students' unit exams, given approximately every 3 weeks during the year. For grade 10, (World History), there 37 quizzes and 10 unit exams. For grade 11, (US History), there were 46 quizzes and 16 unit exams.

Statistical Methods

Baseline Equivalency. The equivalency of intervention and control groups, at each grade, was determined by performing a between groups analysis of variance. For middle school grades, equivalency testing used the Fall NWEA test. For grade 10, equivalency was determined using both the Fall NWEA test and the CSAP test of the students' prior spring (grade 9) test. For grade 11, equivalency was determined using the CSAP test of the prior spring (grade 10) test.

Pretest-Posttest Comparisons. For the middle school grades, a comparison of pretest versus posttest results on the NWEA reading test was made, using Analysis of Variance methods. An individual student's growth from the pretest to the posttest was determined for each student, in both the intervention and matched control groups, across all middle school grades; a between-groups one-way ANOVA comparison of student growth was performed. To control for the variation in baseline reading aptitude, a covariate between-subjects ANOVA was performed with spring NWEA as the dependent variable, and Fall NWEA as the independent variable. A multivariate analysis of variance (MANOVA) for between-subjects effects was also performed to control for the possibility of disproportionate impacts of the intervention in various subgroups, (gender and native-English language status), or teacher effects, (or combinations of such variables), and baseline reading aptitude.

For the high school grades, similar ANOVA and MANOVA analyses were performed. In the 10th grade, pretest-posttest comparisons were performed using for NWEA and CSAP tests. For the 11th grade, pretest-posttest comparison was made by performing a between-subjects covariate ANOVA, using ACT tests as the dependent variable, and the previous year's CSAP scores as the independent variable. Similarly, MANOVA of was performed for the 11th grade, with the ACT scores as the dependent variable, and pretest CSAP scores as the independent variable, with the same other covariates as listed above.

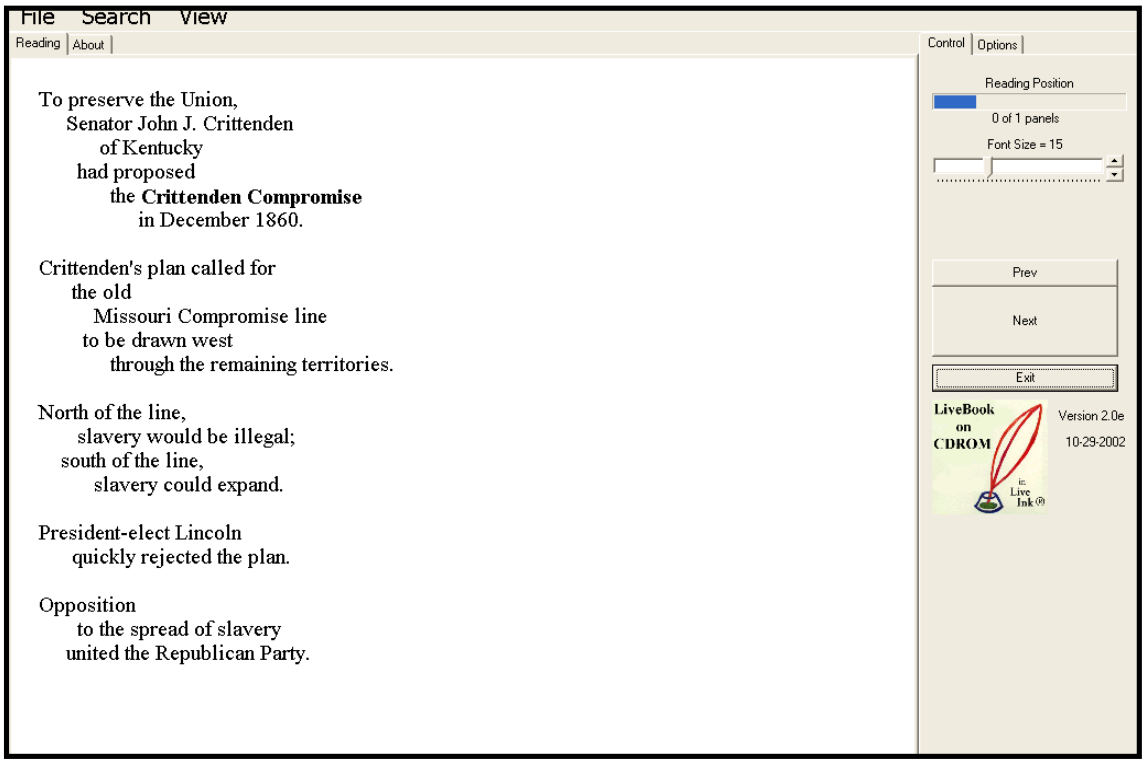
Group Comparisons on Quizzes and Exams. To compare the impact of the intervention on Quiz and Exam scores in 10th and 11th grade students, a Test of Repeated Measures multivariate analysis of variance test was performed. CSAP scores from the previous year, (9th grade spring for 10th graders, and 10th grade spring for 11th graders), were used to rank students by reading achievement into four categories: unsatisfactory (MPP), partial proficient (LP), proficient (MP), or advanced (HP), which were used as a covariate to insure for equivalency between groups.

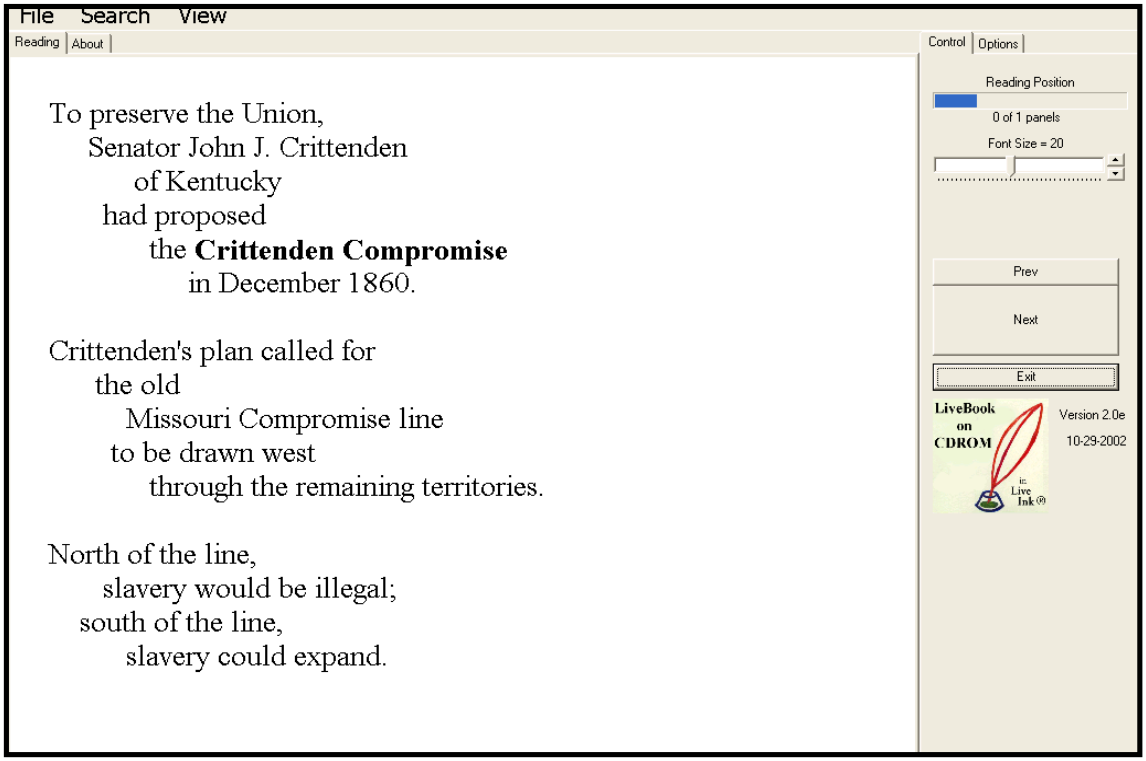
Statistical Computations were performed using the Statistics Package for Social Sciences, version 10.0.

*Grade/Design Equivalency**	*Group*	*Parameter*	*All*	*EL1*	*ESOL*	*Male*	*Female*
6/PMC F = .001 p= .983	Control	N	57	37	20	32	25
		Pretest	*208.4*	*213.5*	*199.1*	*208.5*	*208.3*
	Intervention	N	57	34	23	34	23
		Pretest	*208.3*	*215.5*	*197.8*	*205.8*	*212.4*
7/PMC F = .000 p = .993	Control	N	53	39	14	26	27
		Pretest	*216.7*	*221.6*	*203*	*216.5*	*217*
	Intervention	N	53	43	10	25	28
		Pretest	*216.7*	*220.6*	*200.3*	*216*	*217*
8/PMC F =.099 p =.753	Control	N	62	48	14	29	33
		Pretest	*223.8*	*227.3*	*207.9*	*221.8*	*223.7*
	Intervention	N	62	49	13	27	35
		Pretest	*223.0*	*225.9*	*206.6*	*220.8*	*222.9*
10/RCT NWEA F =.183 p=.670	Control	N	44	27	17	24	20
		Pretest	*226.1*	*229.2*	*221.12*	*225.4*	*226.9*
	Intervention	N	40	28	12	21	19
		Pretest	*227.3*	*229.6*	*221.17*	*226.9*	*227.2*
11/RCT F =1.187 p=.280	Control	N	30	24	6	18	12
		Pretest†	*680*	*678*	*684*	*678*	*686*
	Intervention	N	30	22	8	16	14
		Pretest†	*691*	*699*	*667*	*687*	*691*

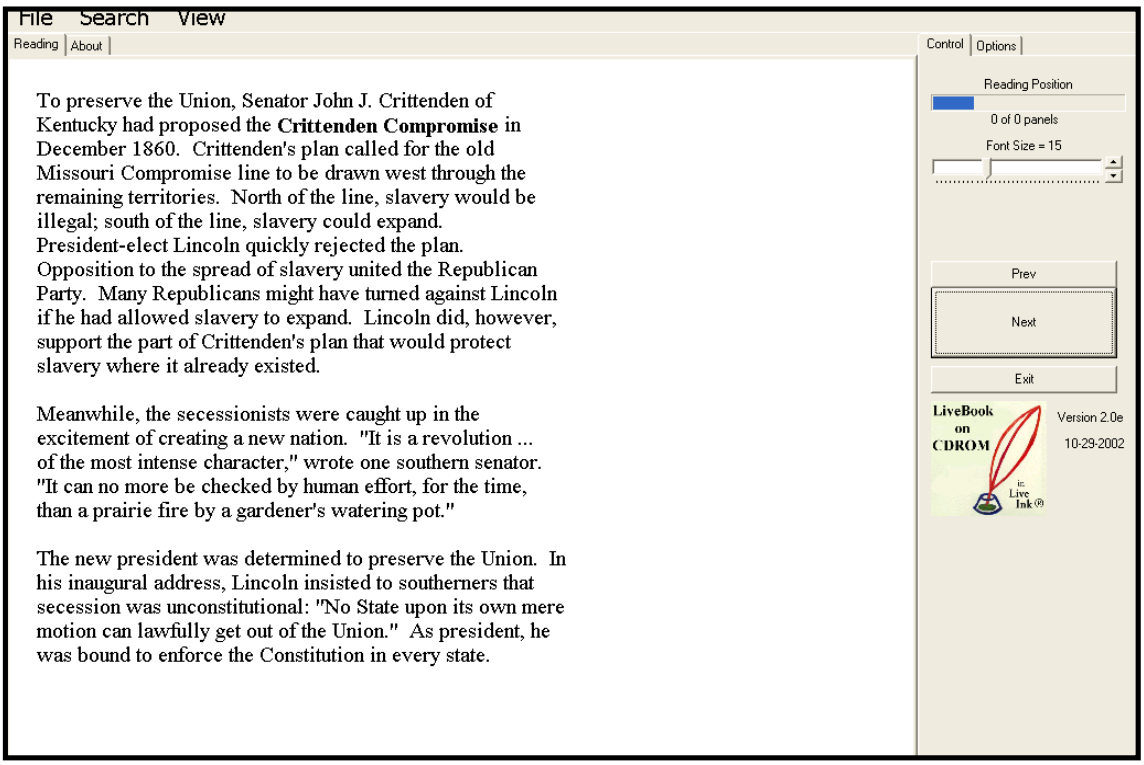
Demographics & Baseline Equivalency of Intervention and Control Groups.
PMC= Prospective Matched-Case Control Trial
RCT = Randomized Control Trial
Pretest = Northwest Educational Association (NWEA) MAP-reading scores for grades 6-8 and grade 10 studies.
Pretest† = CSAP-reading (previous spring, grade 10) score for grade 11 study
Equivalency* analysis= one-way ANOVA between groups (all subgroups)
EL1=native English students
ESOL= non-native English students

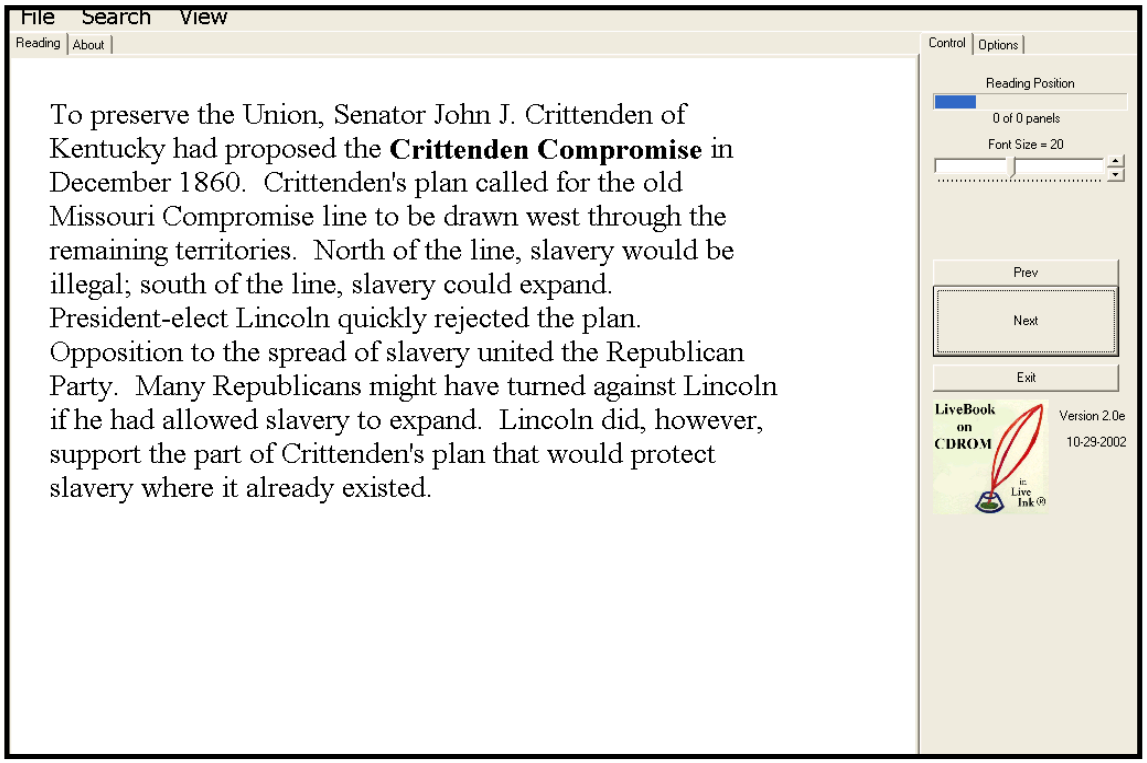
Sample of Live Ink electronic textbook, with font enlargement feature. Both the control and intervention electronic textbooks in the High School randomized controlled trials had font enlargement and light/dark background color options.





Conventional Block text electronic textbook, with font enlargement feature. Both the control and intervention electronic textbooks in the High School randomized controlled trials had font enlargement and light/dark background color options.





Grade 10 Randomized Controlled Trial

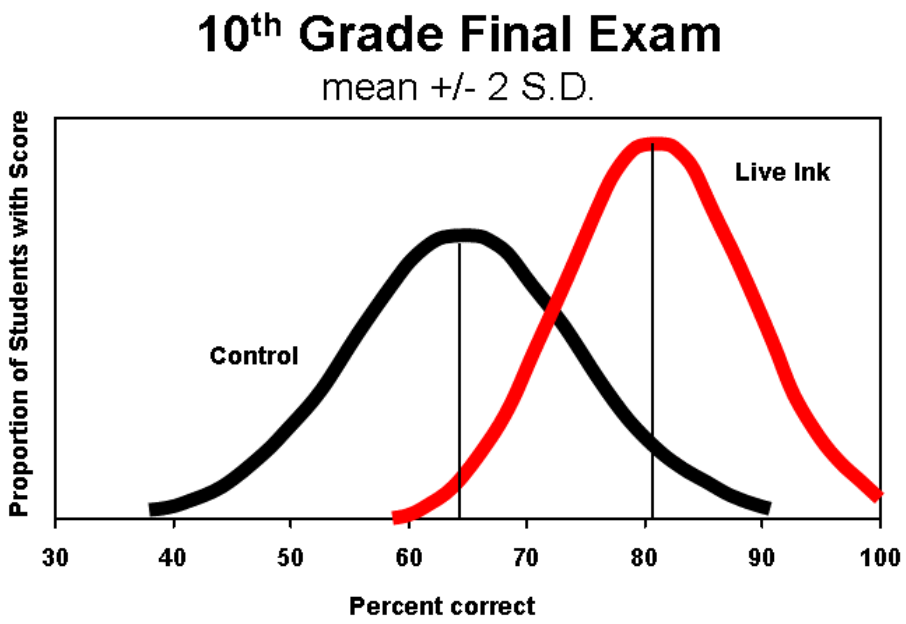
There were 84 total Grade 10 students. Three teachers participated, each teacher having one control class section and one intervention section; for each teacher, randomization of one's two sections to either treatment or control group was made by coin toss. Students read for 25 minutes every other day from the World History textbook used in the course. All classes, across all teachers, read the same textbook chapters, and took identical quizzes after each reading session (total 38) and identical unit exams (total 10) every 3 to 4 weeks during the year. All classes had the same reading proficiency test, (the Northwest Educational Association, NWEA, MAP-reading test), for pretest/posttest assessment of reading proficiency in the fall and spring of the same academic year. Pretest NWEA scores demonstrated statistical equivalence between the control and intervention groups, across gender and native language subgroups.

Results

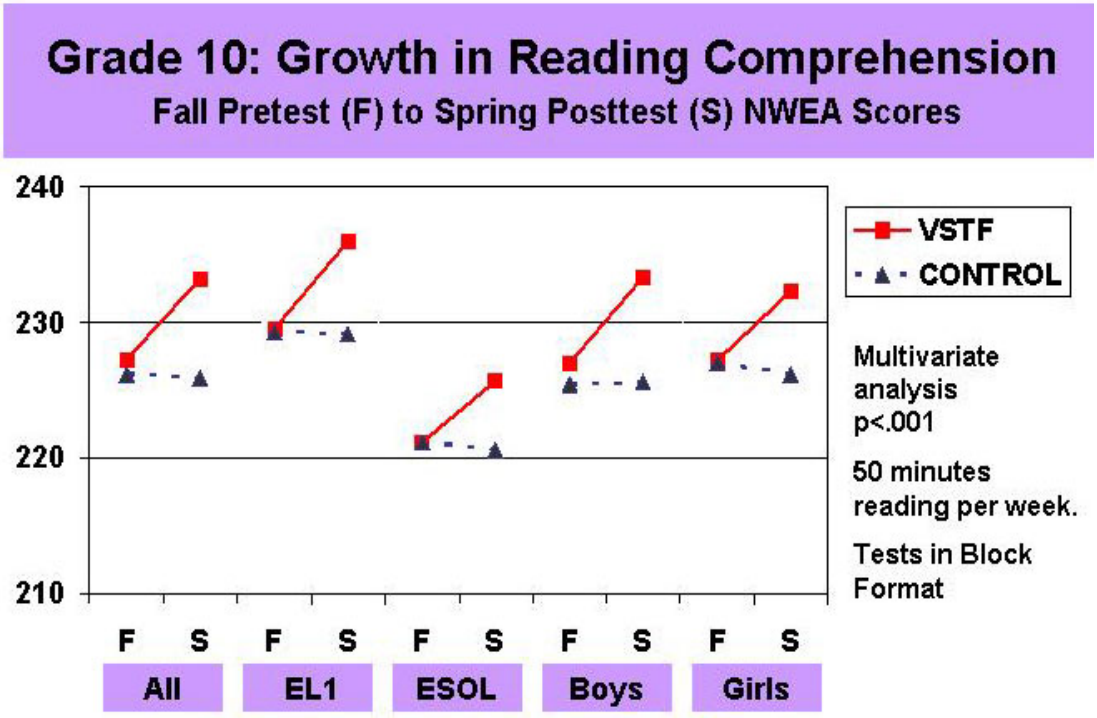
Quizzes: Student scores on quizzes were significantly higher in the Live Ink groups (VSTF); 65 percent of Live Ink students had year-average quiz scores that were higher than the Control's mean year-average.
Unit Exams: Scores on unit exams were also significantly higher in the Live Ink group; 70 percent of Live Ink students had year-average unit exam scores that were higher than the mean year-average score of the Control group.
Final Exam: On the Final Exam, covering material of the entire spring semester, Live Ink students' scores were even more elevated compared to controls: 92 percent of Live Ink students had scores that were greater than the mean Final Exam score of the Control group. The Live Ink group's scores were more than a full-standard deviation higher than Control group's scores.
Post-test Reading Comprehension: The Reading Comprehension test (NWEA) given in the spring showed a significantly higher growth in Live Ink students' reading proficiency compared to the reading comprehension in Control students.

Grade 10 Tests N=84	*Mean Control Score (SD)*	*Mean VSTF Score (SD)*	*Effect Size: VSTF - Control ÷ SD_{all}*	*Percent of VSTF scores > Control Mean*	*F Value**	*P Value**
Reading Comprehension Pretest (NWEA)	*226.09 (9.9)*	*227.28 (11.8)*	*0.11*	*54*	*0.183*	*.983*
All 38 Quizzes	*64.31 (20.9)*	*72.02 (19.7)*	*0.38*	*65*	*28.7*	*<.001*
All 10 Unit Exams	*68.1 (20.1)*	*76.56 (16.26)*	*0.47*	*70*	*6.852*	*0.011*
Final Exam	*63.93 (15.88)*	*81.18 (12.32)*	*1.22*	*92*	*29.97*	*<.001*
Reading Comprehension Posttest (NWEA)	*225.8 (9.9)*	*233.23 (11.1)*	*0.69*	*74*	*8.80*	*.004*
Growth in Reading Comprehension Pretest to Posttest	*-0.295 (6.476)*	*6.282 (7.189)*	*.96*	*82*	*17.503*	*<.001*
**ANOVA and Multivariate Analysis of Variance, including Tests of Repeated Measures*						

Grade 10: Distribution of Scores on Final Exam



Subgroups. Multivariate analyses included subgroups based on native language status, gender, baseline reading proficiency level, and teacher. Significant increases with the Live Ink (VSTF) treatment were seen across all subgroups, including results for quizzes, exams, and reading proficiency. The multivariate analysis also confirmed that the benefits seen in Live Ink group were most directly correlated with the Live Ink intervention itself, and could not otherwise be explained by other factors such as teacher effect or baseline reading aptitude, or by combinations of such factors.



Grade 11 Randomized Controlled Trial

There were 60 total Grade 11 students. Two teachers participated, each teacher having one control class section and one intervention section; for each teacher, randomization of one's two sections to either treatment or control group was made by coin toss. Both groups used laptops for in-class reading -- 25 minutes every other day from their US History textbook. All classes read the same textbook chapters, took identical quizzes after each reading session (total 48), and had identical unit exams (total 14) every 2 to 3 weeks during the year. All classes had the same reading proficiency test, (Colorado Standards CSAP-reading test), for pretest assessment of reading proficiency in the spring of the preceding academic year (10); pretest CSAP scores demonstrated statistical equivalence between the control and intervention groups, across gender and native language subgroups. A post-test measurement for Reading Comprehension, the ACT-reading test (given to all juniors in the State of Colorado), was given in the spring of the study year (11).

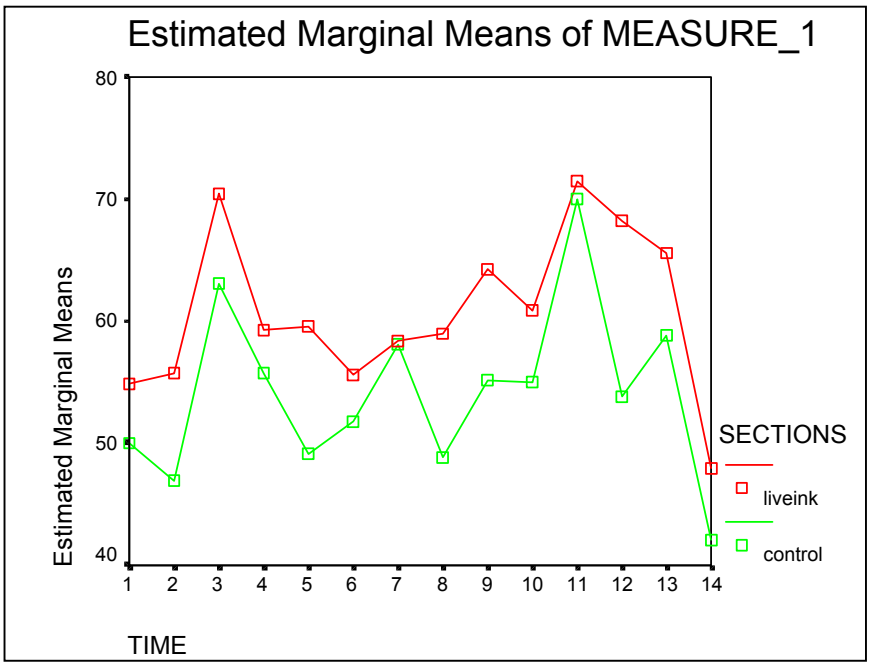
Results

Quizzes: Based on a test of repeated measures multivariate analysis of all of the year's quiz scores, student scores were significantly higher in the Live Ink groups (VSTF), even when controlling for variations in baseline reading proficiency; 64 percent of Live Ink students had year-average quiz scores that were higher than the mean year-average of the Control group.
Unit Exams: Similarly, multivariate analyses found that scores on unit exams were also significantly higher in the Live Ink group; 68 percent of Live Ink students had year-average unit exam scores that were higher than the mean year-average score of the Control group.
Final Exam: On the Final Exam, covering material of the entire spring semester, Live Ink students' scores were even more elevated compared to controls: 78 percent of Live Ink students had scores that were greater than the mean Final Exam score of the Control group.
Post-test Reading Comprehension: Reading Comprehension test (ACT) given in the spring showed significantly higher scores for Live Ink students' reading proficiency compared to the reading comprehension in Control students; the multivariate analysis used pretest CSAP scores as the covariate and ACT reading scores as the dependent variable.

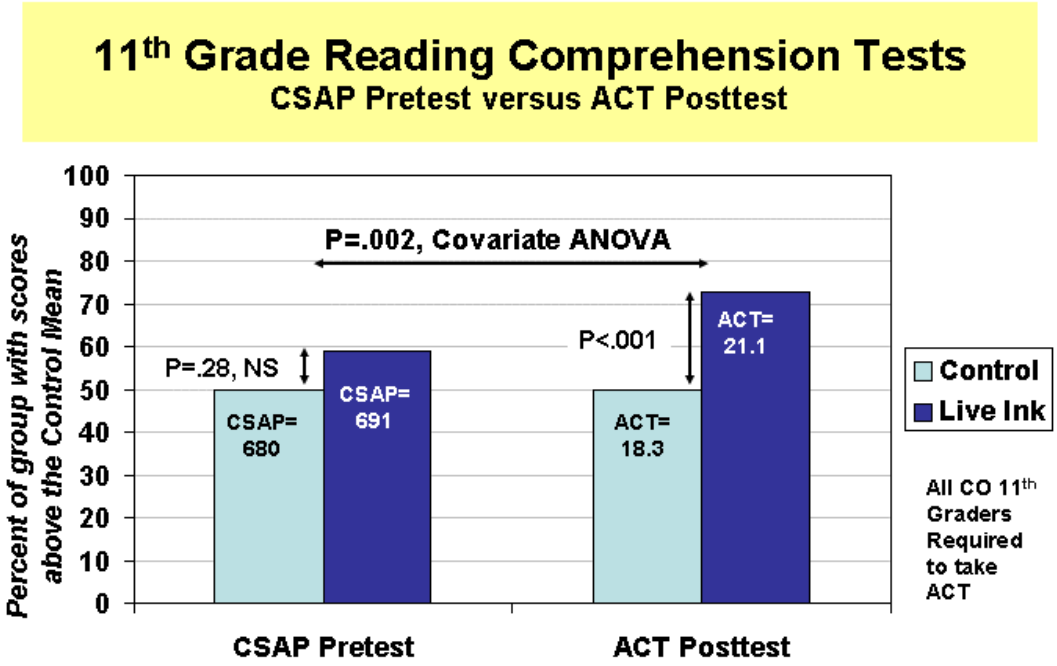
Grade 11 Tests N=60	*Mean Control Score (SD)*	*Mean VSTF Score (SD)*	*Effect Size: VSTF - Control ÷ SD_{all}*	*Percent of VSTF scores > Control Mean*	*F Value**	*P Value**
Reading Comprehension Pretest (CSAP-10)	*679.62 (35.33)*	*690.94 (44.25)*	*0.28*	*59*	*1.187*	*0.28*
All 48 Quizzes	*76.38 (17.62)*	*81.65 (15.46)*	*0.32*	*64*	*5.647*	*0.021*
All 14 Unit Exams	*53.73 (16.41)*	*61.18 (15.88)*	*0.46*	*68*	*5.032*	*0.029*
Final Exam	*83.48 (12.12)*	*90.03 (8.75)*	*0.63*	*78*	*5.185*	*0.019*
Reading Comprehension Posttest (ACT)	*18.35 (5.01)*	*21.06 (4.46)*	*0.57*	*73*	*17.286*	*<.001*

**ANCOVA and Multivariate Analysis of Variance, including Tests of Repeated Measures*

Grade 11: Scores on unit exams given about every 3 weeks.



Subgroups. Multivariate analyses included subgroups based on native language status, gender, baseline reading proficiency level, and teacher. Significant increases with the Live Ink (VSTF) treatment were seen across all subgroups, including results for quizzes, exams, and reading proficiency. The multivariate analysis also confirmed that the benefits seen in Live Ink group were most directly correlated with the Live Ink intervention itself, and could not otherwise be explained by other factors such as teacher effect or baseline reading aptitude, or by combinations of such factors.

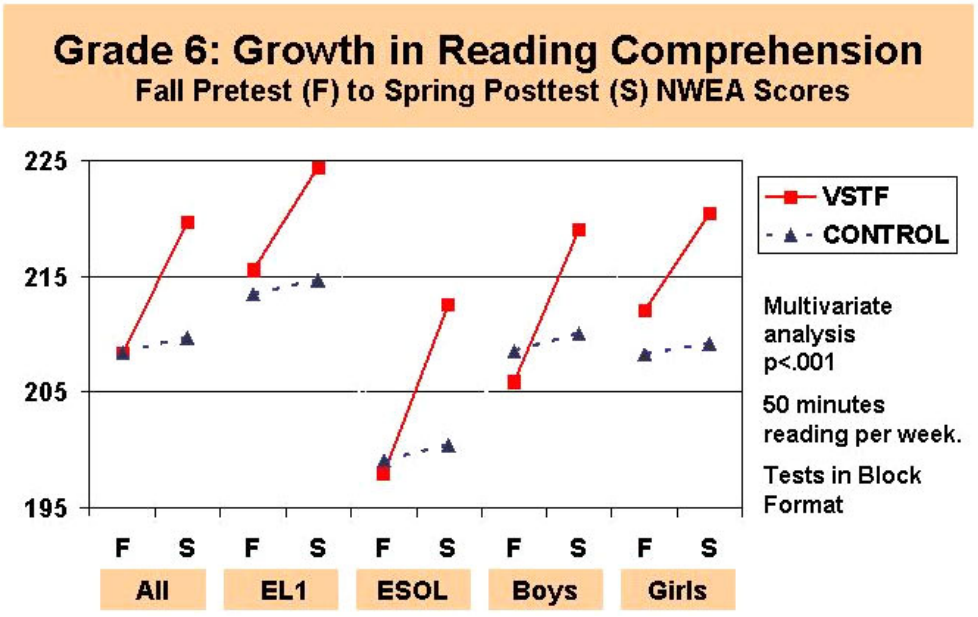


Grade 6: Prospective, Matched-Case Controlled Trial

There were 114 total Grade 6 students studied: 57 in the Live Ink (VSTF) Group, and 57 in the control group. Live Ink students had Social Sciences teachers and Language Arts teachers who taught the same cohort of students, i.e., a "team". All middle school students in the district were given identical pretest/posttest reading proficiency tests (the NWEA MAP test for reading). Controls from 3 other middle schools were matched with individual students in the intervention team according to three parameters: first, by baseline Fall NWEA-reading scores; second, by non-native versus native English status; and third, by gender. Statistical analysis confirmed that the intervention and control groups were highly equivalent.

Grade 6 Reading Comprehension Tests (NWEA) N=114	*Mean Control Score (SD)*	*Mean VSTF Score (SD)*	*Effect Size: VSTF - Control ÷ SD_{all}*	*Percent of VSTF scores > Control Mean*	*F Value**	*P Value**
Pretest	*208.43 (17.59)*	*208.36 (18.26)*	*0*	*50*	*.001*	*.983*
Posttest	*209.68 (18.37)*	*219.67 (11.88)*	*0.66*	*80*	*16.031*	*<.001*
Growth	*1.263 (8.54)*	*11.33 (10.9)*	*1.04*	*82*	*30.157*	*<.001*
**ANOVA and Multivariate Analysis of Variance*						

Subgroups: Multivariate analyses included subgroups based on native language status, gender, baseline reading proficiency level, and teachers. Significant increases with the Live Ink (VSTF) treatment were seen across all subgroups. The multivariate analysis also confirmed that the benefits seen in Live Ink group were most directly correlated with the Live Ink intervention itself, and could not be explained by other factors such as teacher effect or baseline reading aptitude, or by combinations of such factors.

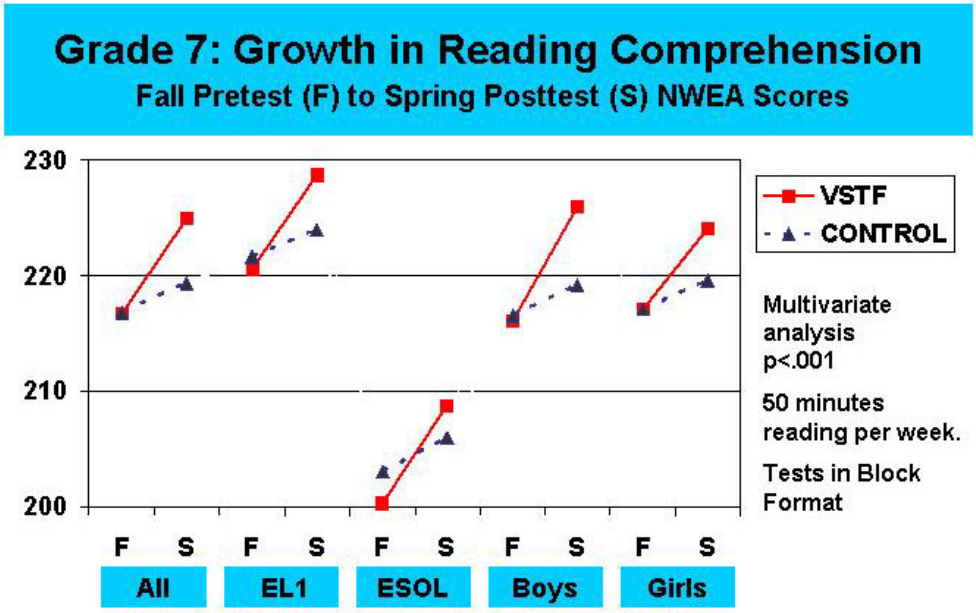


Grade 7: Prospective, Matched-Case Controlled Trial

There were 106 total Grade 7 students studied: 53 in the Live Ink Group, and 53 in the control group. Live Ink students were in two teams in two middle schools, each team with Social Sciences teachers and Language Arts teachers who taught the same cohort. All middle school students in the district were given identical pretest/posttest reading proficiency tests (the NWEA MAP test for reading). Controls from other teams in 4 middle schools in the district were matched with individual students in the intervention teams according to three parameters: first, by baseline Fall NWEA-reading scores; second, by non-native versus native English status; and third, by gender. Statistical analysis confirmed that the intervention and control groups were highly equivalent.

Grade7 Reading Comprehension Tests (NWEA) N=106	*Mean Control Score (SD)*	*Mean VSTF Score (SD)*	*Effect Size: VSTF - Control ÷ SD_{all}*	*Percent of VSTF scores > Control Mean*	*F Value**	*P Value**
Pretest	*216.78 (14.1)*	*216.75 (14.59)*	*0*	*50*	*.000*	*.993*
Posttest	*219.31 (13.98)*	*224.94 (13.34)*	*.41*	*66*	*4.535*	*.036*
Growth	*2.537 (5.12)*	*8.245 (6.09)*	*1.02*	*82*	*27.587*	*<.001*
**ANOVA and Multivariate Analysis of Variance*						

Subgroups: Multivariate analyses included subgroups based on native language status, gender, baseline reading proficiency level, and teachers. Significant increases with the Live Ink (VSTF) treatment were seen across all subgroups. The multivariate analysis also confirmed that the benefits seen in Live Ink group were most directly correlated with the Live Ink intervention itself, and could not be explained by other factors such as teacher effect or baseline reading aptitude, or by combinations of such factors.

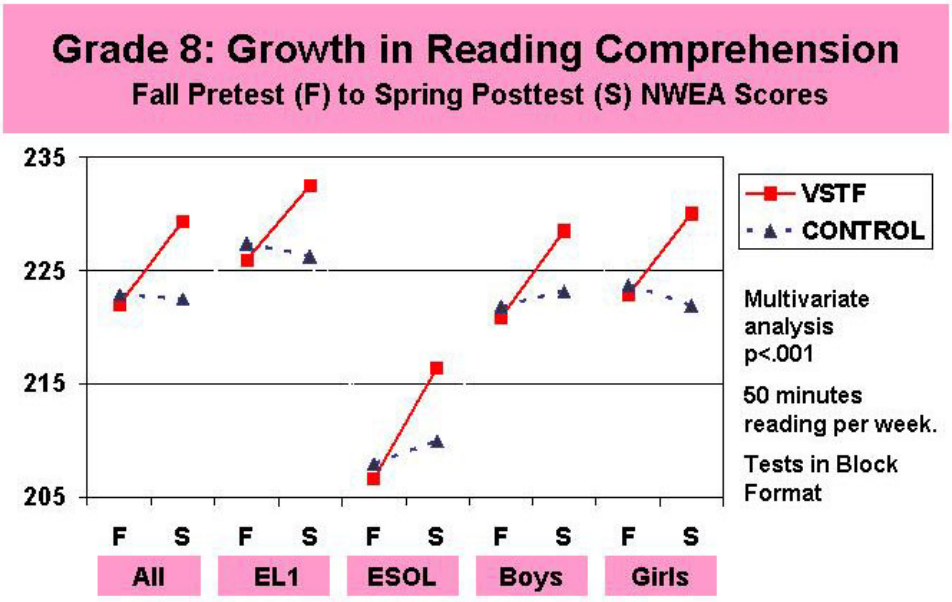


Grade 8: Prospective, Matched-Case Controlled Trial

There were 124 total Grade 8 students studied: 62 in the Live Ink Group, and 62 in the control group. Live Ink students were in one team, and had a group of Social Sciences teachers and Language Arts teachers who taught the same cohort of students. All middle school students in the district were given identical pretest/posttest reading proficiency tests (the NWEA MAP test for reading). Controls from other teams in 4 other middle schools in the district were matched with individual students in the intervention teams according to three parameters: first, by baseline Fall NWEA-reading scores; second, by non-native versus native English status; and third, by gender. Statistical analysis confirmed that the intervention and control groups were highly equivalent.

Grade 8 Reading Comprehension Tests (NWEA) N=124	*Mean Control Score (SD)*	*Mean VSTF Score (SD)*	*Effect Size: VSTF - Control ÷ SD_{all}*	*Percent of VSTF scores > Control Mean*	*F Value**	*P Value**
Pretest	*222.82 (14.97)*	*221.97 (15.23)*	*.06*	*48*	*.099*	*.753*
Posttest	*222.43 (18.05)*	*229.35 (12.82)*	*.45*	*67*	*6.05*	*.015*
Growth	*1.251 (5.77)*	*7.322 (5.901)*	*1.04*	*85*	*33.425*	*<.001*
**ANOVA and Multivariate Analysis of Variance*						

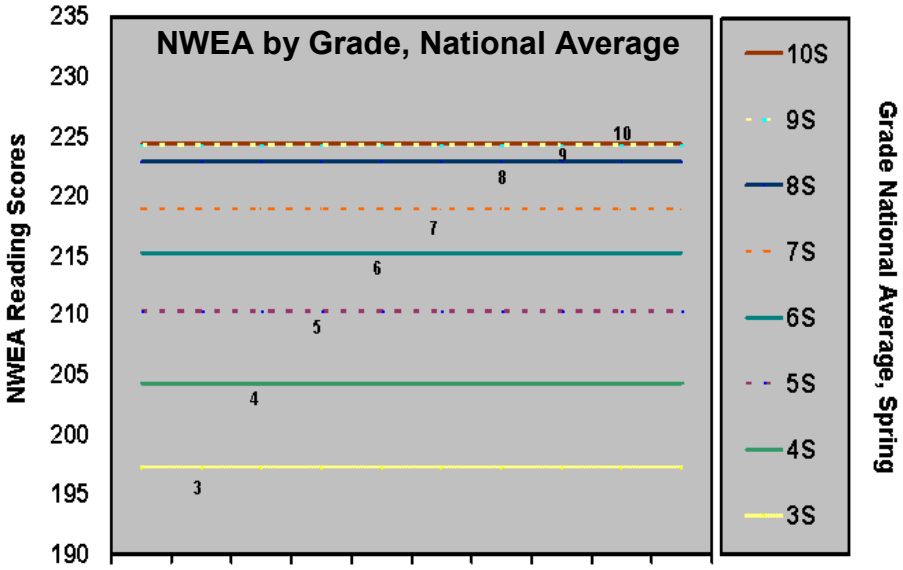
Subgroups: Multivariate analyses included subgroups based on native language status, gender, baseline reading proficiency level, and teachers. Significant increases with the Live Ink (VSTF) treatment were seen across all subgroups. The multivariate analysis also confirmed that the benefits seen in Live Ink group were most directly correlated with the Live Ink intervention itself, and could not be explained by other factors such as teacher effect or baseline reading aptitude, or by combinations of such factors



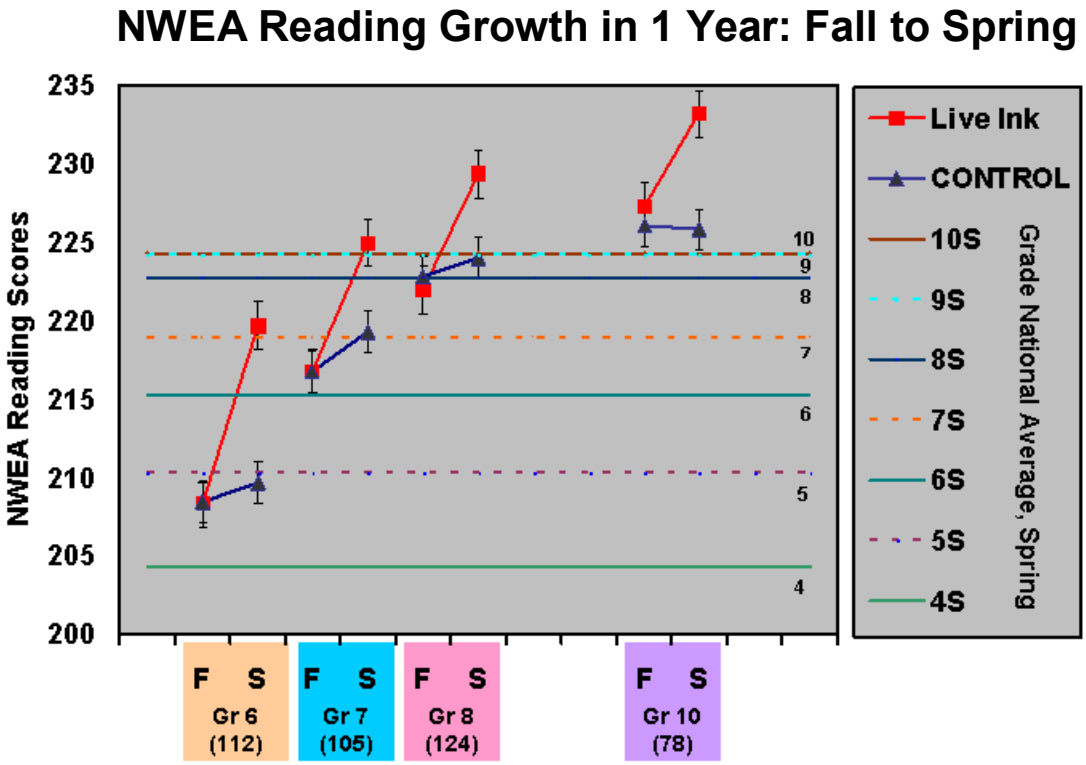
Multi-grade Assessment of Relative Educational Impact.

To assess the relative educational impact of the intervention, it was possible to use the NWEA scores across multiple grades, and to use a national average NWEA score for each grade.

The NWEA Reading Test has been validated over one million students nationally. The average national grade levels for the NWEA scores in spring are shown at right.

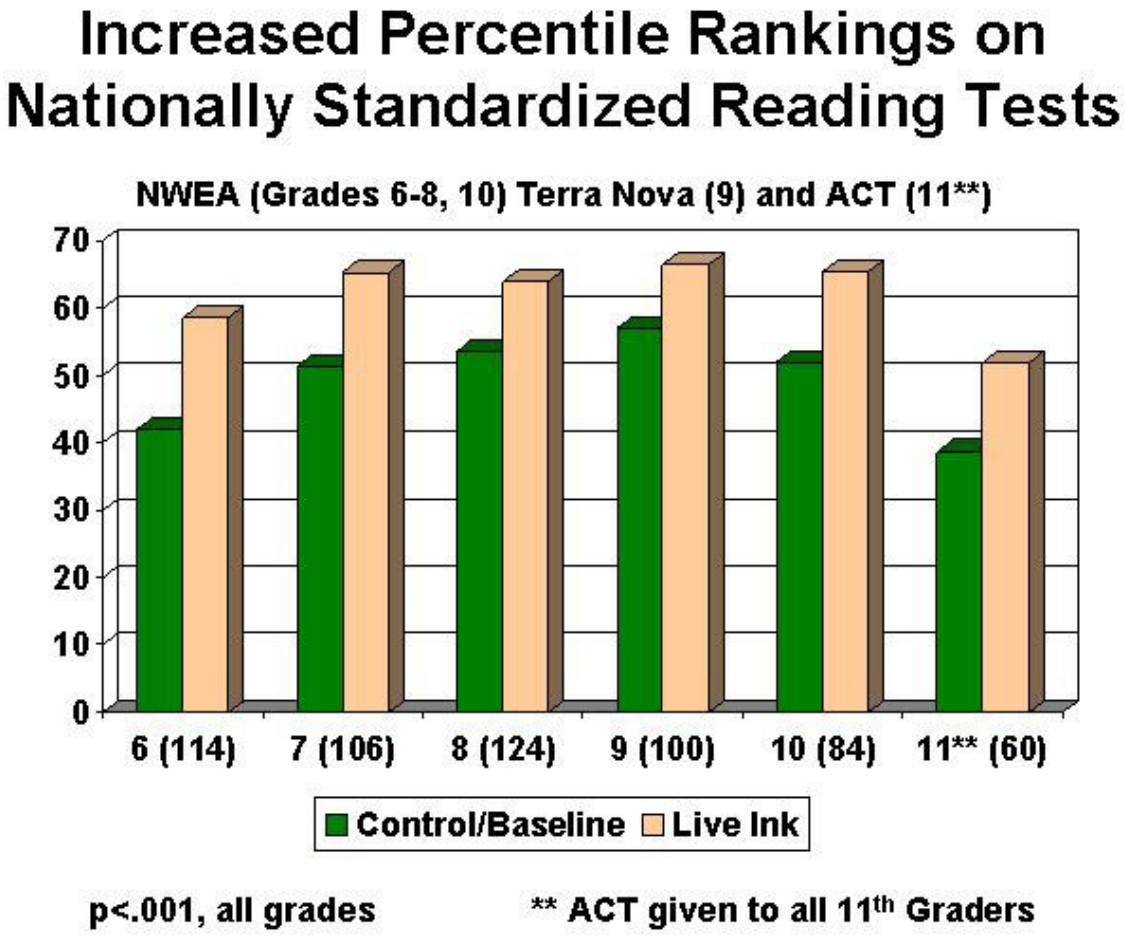


For this study, the pretest (F) and posttest (S) NWEA scores, in both control and intervention groups, are shown for grades 6 though 8 and grade 10, in the graph below.



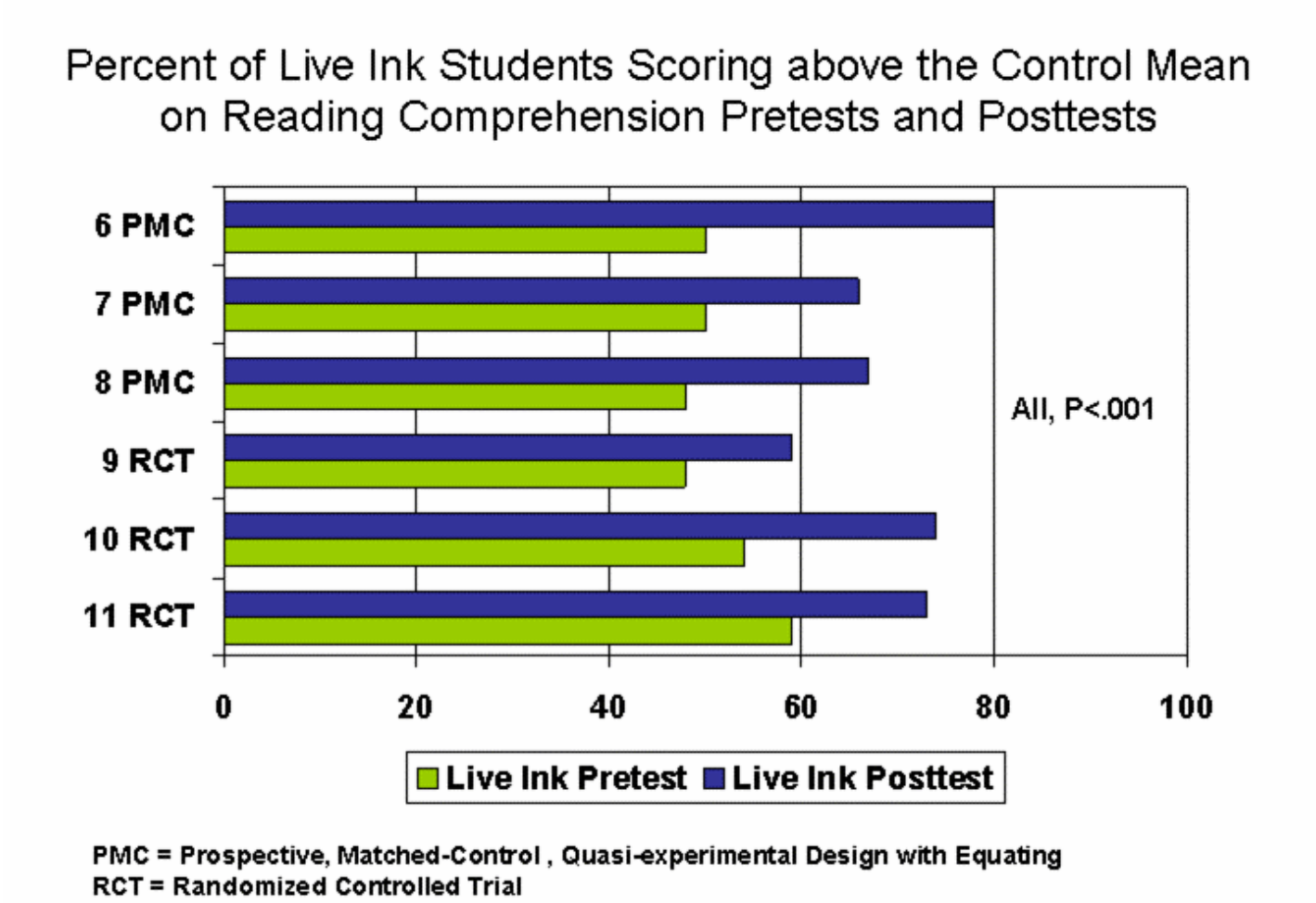
This comparison demonstrates that , in any given middle school year or in the early high school years, the educational impact of the intervention is equivalent to making *2 to 3 grade-levels' of progress* in the span of just 1 year. Moreover, in grade 10, (a grade in which, nationally, negligible progress occurs, and scores are identical to grade 9), Live Ink students made substantial progress, adding 2 grade-levels of progress to their proficiency. This result is notable in that it did not require additional time in a reading class, only a content area class, and was associated with improved academic achievement in the content area.

Another yardstick to measure the relative educational impact of the intervention is the increase in students' national percentile rankings in nationally standardized reading comprehension tests. By controlling for the age of students, the increase in national percentile rankings provides a way to assess the relative impact of the intervention across different grades, even if the actual starting percentile ranking might vary from grade to grade. One can also compare different types of studies, such as NWEA used in grades 6-8 and 10, the ACT in grade 11, and the Terra Nova® reading test previously used in grade 9. The following graph illustrates the impact on national percentile rankings, using several different reading comprehension tests, across grades 6 through 11 (including the previous grade 9 RCT).

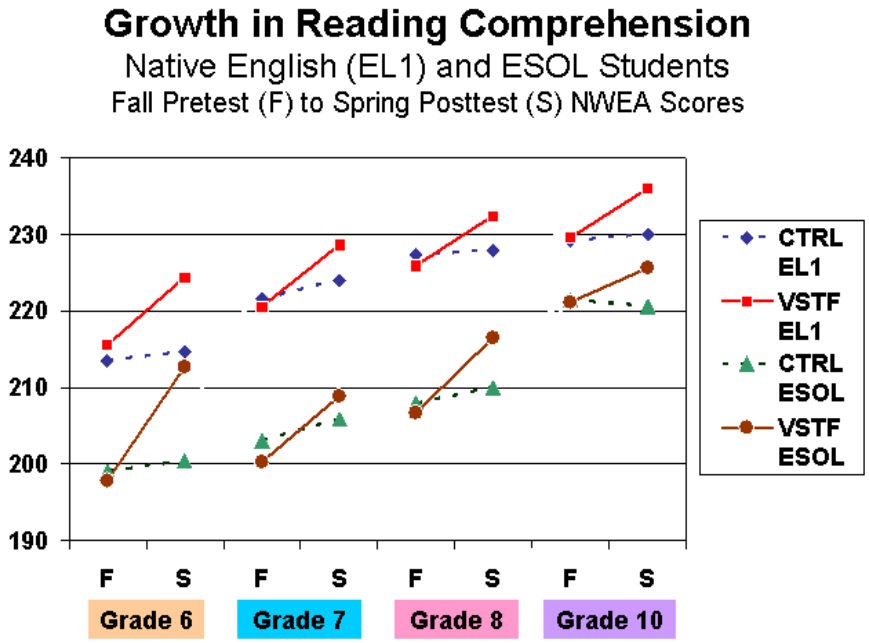


As illustrated in the graph, even though the baseline/control national percentile rankings varied from the 38th percentile to the 55th percentile, the impact of the intervention was an increase that was consistently between 10 to 15 percentile points across all grades, and with different types of reading comprehension tests.

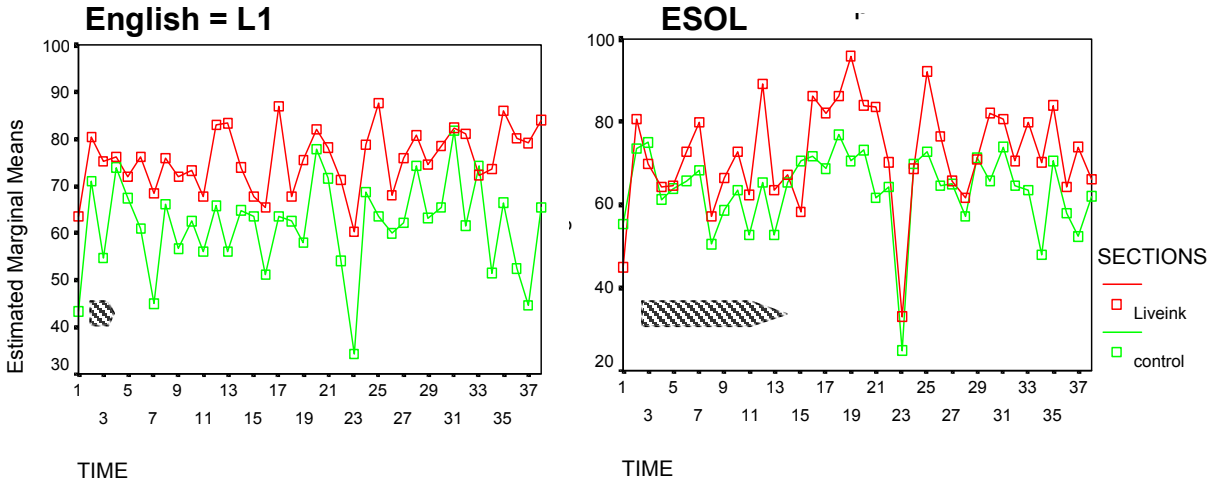
One can also demonstrate the effect size of the intervention on Reading Comprehension across multiple grades, and across different studies in which different research designs and testing instruments were used, by comparing the percentage, (in both pretest and posttest), of intervention students who had scores above the control mean. This comparison helps account for slight pretest differences that the intervention group had compared to the control group (a possibility that randomized controlled trials are subject to). This comparison also accounts for, in the case of the 11th grade study, the fact that a different type of test was used for pretest (CSAP) than for posttest (ACT). Additionally, this comparison can also include the prior grade 9 study, which had used different testing instrument (Terra Nova®). Finally, this method of comparison can be readily appreciated by educators, because it demonstrates how much better intervention students will perform relative to comparable control students.



This comparison reveals that the Live Ink intervention consistently increases reading comprehension to a similar, substantial degree -- across multiple grades, among different teachers and schools, with different research design methods, and when different types of reading comprehension tests are used. Among high school students, an additional 11 to 20 percent of Live Ink students scored above the Control Mean on the posttest after the intervention than they did on the pretest before the intervention. Among middle school students, an additional 16 to 30 percent of Live Ink students scored above the Control Mean on the posttest after the intervention than they did on the pretest before the intervention.



Non-native English Readers. Various analyses demonstrated that the impact of the intervention was not limited to either native English or non-native English students: both groups benefited, and to similar degrees. Similar benefits were seen in quizzes and exams (in the high school studies) and in reading comprehension (across all grades, see graph above). The quiz responses did suggest, however, that non-native English students may have required more reading sessions before an appreciable difference between control and intervention groups emerged; this suggests that more "syntactic awareness" must accrue among the non-native English students before being able to apply the visual-syntactic cues of the intervention to full advantage (see graph below). Nevertheless, by the end of the year in most grades, ESOL students had closed one-half to nearly the full gap between ESOL and native English students in the control groups. Moreover, in the 11th grade, the Live Ink method enabled ESOL students to achieve the same ACT reading score as EL1 students in the intervention group.

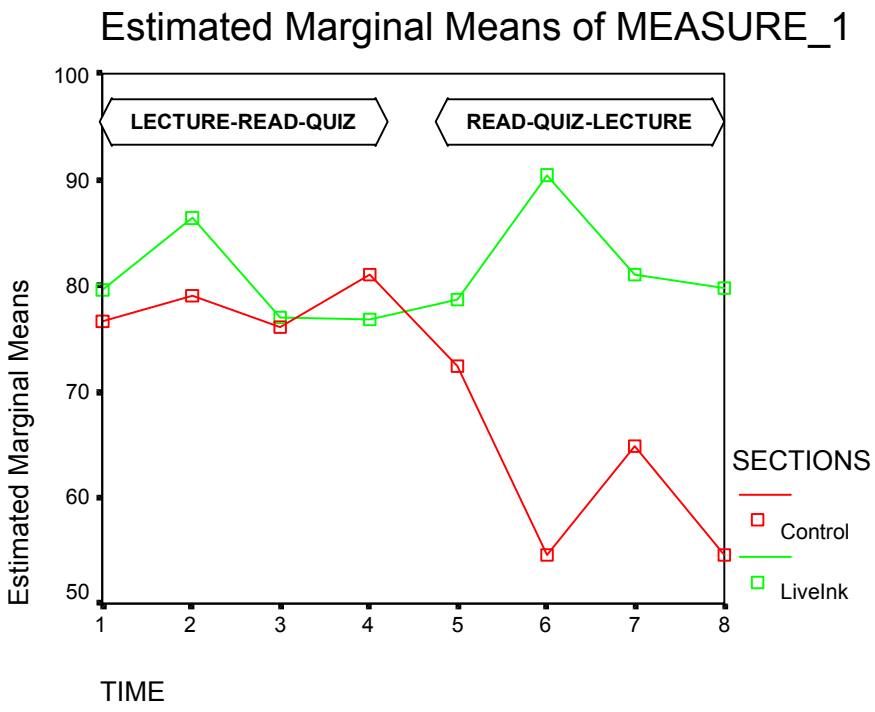


10th Grade Quiz Scores: Varied time to impact EL1 students using VSTF had an immediate increase in quiz scores over controls, but ESOL students using VSTF required about 8 reading sessions before getting an increase in quiz scores over controls.

Advanced Placement (AP) 11th and 12th Grade Students

An AP study evaluated two equivalent groups of American History students; equivalency was determined by a PLACE test that guaranteed that students could read at a college level. The first half of the year, all students read regular textbooks independently, taking quizzes periodically. In the second half of the year, in-class reading began, one of the class sections read in the computer lab with VSTF, while the other class read from the paper textbook. Quizzes were from a test generator provided by the textbook company, and were administered directly after an in-class reading session. The quizzes at minimum were thirty multiple-choice questions per section read. The data points on the graph below represent scores for the second semester only. For first 4 quizzes of the second semester, students from both the control group and the VSTF group were listening and taking notes from a teacher's lecture about the section topic; then the reading was used as a backup to the lecture and the quiz came right after the reading session (LECTURE-READ-QUIZ). For quizzes 5 through 8, the teacher reversed the process, having students in both groups read and take a quiz first, and then the teacher lectured to the section as a backup (READ-QUIZ-LECTURE).

The experiment showed that, for quizzes 5-8, without the auditory, traditional instruction, the AP students in the control group dropped quiz score averages, dramatically. By contrast, the students in the Live Ink group maintained high quiz scores even without having the lecture before the quiz. The graph below was generated from a repeated measures analysis; the ANOVA compares between subjects effects for every data point during the second semester experiment, regardless of the lecturing sequence.



Advanced Placement Quizzes.
Live Ink versus Control for all 8 quizzes: F= 28.891, p<.001 (ANOVA, between subjects).

Discussion

Reproducibility. This US Department of Education-funded research reproduced, across grades 6 though 8, and grades 10 and 11, the same pattern of benefit as had been seen in earlier studies in 9th graders. Notably, very similar patterns of benefit are seen, even when a variety of teachers, schools, grade levels, reading materials, computer displays, study designs, and testing instruments are involved.

Impact on Retention and Learning. Across grades 9, 10 and 11, Live Ink has been found to raise students' scores on quizzes given immediately after each reading session, as well as on exams that covered several weeks' worth of instruction. The impact of Live Ink on quizzes could result from effects on short-term recall and visual memory, in addition to comprehension. However, the impact of Live Ink on exams (whose content would have been read days and weeks earlier) would be less likely to be simply the result of improved short term recall and visual memory alone, and is more likely the result of higher-order comprehension and long-term learning.

Impact on Reading Comprehension. The impact of Live Ink on long-term reading proficiency (in any text format), previously observed in grade 9, has been reproduced across grades 6 through 11 -- using nationally standardized reading proficiency tests that are presented in conventional format. A particularly large increase at grade 6 suggests that Live Ink may benefit even younger readers, at grade 5 or lower.

No additional reading courses, personnel, or teacher training. The 14 teachers who used the Live Ink method in their classrooms were content area teachers, not reading specialists. Other than a one-hour seminar on the research protocol at the beginning of the year, these teachers did not undergo any additional training in reading comprehension or reading instruction. Rather, the implementation consisted simply of getting the laptops, or going to the computer lab, and reading each session's reading material.

Randomized Controlled Trials and Prospective Matched-Case Controlled Trials. The two different study designs -- Randomized Controlled Trials (RCT) at the High School level, and Prospective, Matched-Case Controlled Trials (PMCT) at the Middle School level -- corroborate and complement each other. The RCTs involved identical reading sessions in both the control and intervention group; the observation that Live Ink's impact on reading proficiency is similar in both the RCT and PMCT suggests that the Middle School students would have had similar results if an RCT had been used. Conversely, the positive results in the PMCT in Middle School students indicates that the Live Ink benefit is sustained even when the control group remains in its most natural condition (rather than a more restrictive condition, as is the case in the RCT control groups).

Within-teacher randomization and individual-level analysis. In contrast to other RCT's in educational research, in which the randomization method would assign a teacher (and the teacher's class or classes) to *either* the intervention group *or* the control group, in this study, the high school RCT's used a *within*-teacher randomization design that had each teacher, at each grade level, teach both an intervention class and a control class. In this way, possible teacher-based variance, or aggregation bias, was counter-balanced between the control and intervention groups. Moreover, the high school schedule also made it possible for teachers to teach to both their intervention class and their control class on identical days -- minimizing variability in course and lecture content. In addition, ANOVA of intervention and control groups' pretest scores, across all demographic subgroups, demonstrated a high level of equivalency between the intervention and control groups; controls' pretest/posttest growth was also equivalent to the national average, indicating a lack of negative teacher bias against control groups. Furthermore, most advanced students took AP courses, and thus were not part of the larger RCT's (but are reported separately); in this way, a potential confounding effect of uneven distribution of these better readers between intervention and control groups was avoided. Finally, the nature of the intervention itself, i.e., an alternative text format, was independent of teacher behavior, further reducing sources of variance at the group level.

Although research at multiple sites will be needed to demonstrate generalizability, and will involve analysis at the teacher (i.e., group) level, the large effect sizes demonstrated in the current study, (approximately 1 full standard deviation for growth in reading comprehension), combined with the measures listed above to reduce sources of variance at the teacher level, make it quite likely that additional research will show statistical significance similar to what was found with the individual-level analysis reported here.

Increased Impact with Greater Use. The especially large impact of Live Ink on the final exams -- at grades 9 (the previous study), 10, and 11 -- also indicates that the impact of Live Ink may increase with prolonged use. Additional research will evaluate the possible impact of using Live Ink for several consecutive years.

Non-Native English Readers. Live Ink helps non-native English students significantly, across all grades. The observation that non-native English readers may require at least several sessions of Live Ink reading before beginning to manifest a benefit from it also warrants further research on the impact of Live Ink over longer periods.

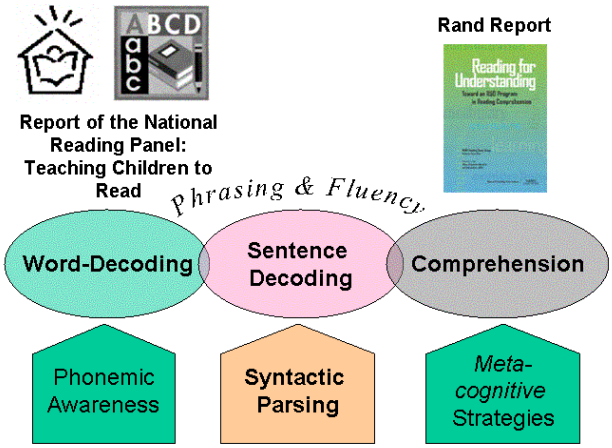
Curriculum-based Intervention. In-class reading sessions were used in the RCTs to assure adherence to the research protocol in both the control and intervention groups; the control group's in-class reading time was identical to the intervention group's in-class reading time. In the PMCTs, (where control groups did not necessarily have regular in-class reading sessions), it is possible that the increases seen were the result of more minutes per week spent reading, rather than the result of reading Live Ink texts per se. However, in both the RCT and the PMCT, the reading material consisted of only that material which students were expected to complete for the content requirements of a standard curriculum.

Some of Live Ink's benefits may be based on the method's ability to encourage students to actually read the text rather than merely forage it; this is a notable effect, because it can be achieved in unsupervised settings. For example, it opens up the possibility that students could read content-area text in the Live Ink format from home over the Internet, and still obtain significant benefits. In addition, in the AP pilot study, students scored as well on quizzes after having only read the material compared to having both read and heard a lecture on the material.

An Integrative Model: Increasing Syntactic Awareness, Fluency, and Comprehension.

Determining how the visual-syntactic formatting method increases reading proficiency (in any text format) will require further study. The mechanism may be through increasing syntactic awareness -- with an explicit and, (compared to diagramming), relatively transparent syntactic edifice that can be perceived in conjunction with the reading of the text itself. Live Ink formatting may serve as a "visual scaffolding" to guide reading with syntactic cues similar to those found in a teacher's "modeling" of fluent reading. On the level of phrases, syntactic awareness training has been shown to increase reading comprehension (Weaver, 1979). There is also evidence that syntactic awareness, relative to phonological awareness, plays an increasingly important role with increasing grade levels (Roth, Speece, Cooper, & De le Paz, 1996). The current study provides evidence for a model of syntactic parsing and "sentence decoding" as key underpinnings of fluency that serve as a bridge between word-decoding (National Reading Panel, 2000) and higher order comprehension (RAND, 2002) as shown below.

Syntactic Sentence-Decoding: Bridging Word-Decoding and Comprehension



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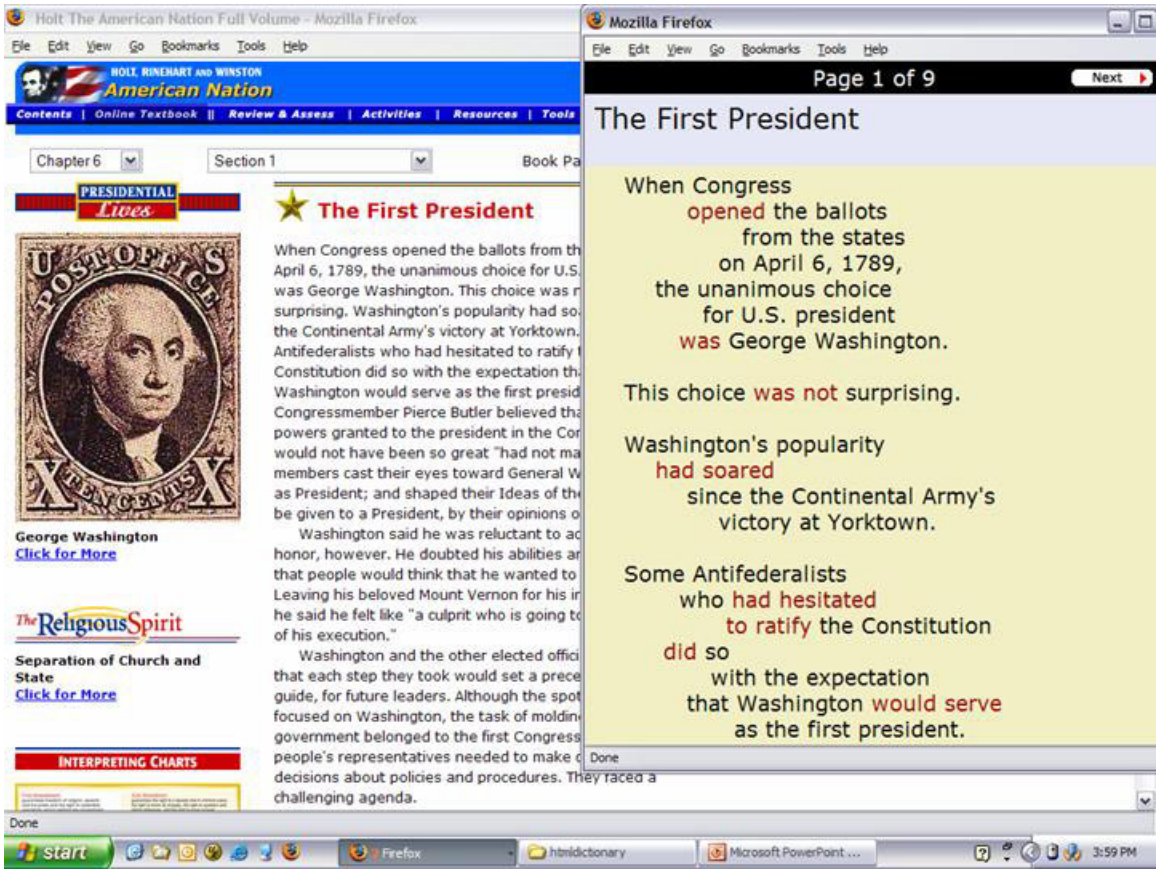

References

Derouzos, M. (1997). *What will be: How the new world of information will change our lives.* San Francisco, CA: HarperCollins/HarperEdge.

National Center for Educational Statistics (2003). The Nation's Report Card: Reading Highlights 2003 NCES Number: 2004452 Release Date: November 13, 2003 http://nces.ed.gov/pubsearch/getpubcats.asp?sid=031#017

National Reading Panel. (2000). *Report of the National Reading Panel: Teaching children to read.* Washington, DC: National Institute of Child Health and Human Development, National Institutes of Health. Available (retrieved April 2005): www.nichd.nih.gov/publications/nrp/report.htm

Pew Internet & American Life Project. (2005). *Report 4. Internet: The mainstreaming of online life.* Washington, DC: Author. Available (retrieved April 2005): www.pewinternet.org/pdfs/Internet_Status_2005.pdf

RAND Reading Study Group. (2002). *Reading for understanding: Toward an R&D program in reading comprehension*. Santa Monica, CA: RAND. Available (retrieved April 2005): www.rand.org/multi/achievementforall/reading/readreport.pdf

Roth, F., Speece, D., Cooper, D., & De le Paz, S. (1996). Unresolved mysteries: How do metalinguistic and narrative skills connect with early reading? *Journal of Special Education*, *30*, 257–277.

Sum, A. (1999, September). *Literacy in the labor force: Results from the National Adult Literacy Survey*. Washington, DC: National Center for Education Statistics, Office of Educational Research and Improvement, U.S. Department of Education. Available (retrieved April 2005): http://nces.ed.gov/pubs99/1999470.pdf

Sum, A., Kirsch, I., & Taggart, R. (2002). *The twin challenges of mediocrity and inequality: Literacy in the U.S. from an international perspective.* Princeton, NJ: Educational Testing Service. Available (retrieved April 2005): www.ets.org/research/pic/twinchall.pdf

Walker, S., Schloss, P., Fletcher, C.R., Vogel, C.A., & Walker, R.C. (2005, May/June). Visual-Syntactic Text Formatting: A new method to enhance online reading. *Reading Online, 8*(6). Available: http://www.readingonline.org/articles/art_index.asp?HREF=r_walker/index.html

Weaver, P.A. (1979). Improving reading comprehension: Effects of sentence organization instruction. *Reading Research Quarterly*, *15*(1), 127–146. Available: links.jstor.org/sici?sici=0034-0553%281979%2915%3A1%3C129%3AIRCEOS%3E2.0.CO%3B2-D

GRADE-TEST-TIME	GROUP/SUB	Mean	SD	SEM	95%CI -- LOWER	95%CI - UPPER	MEDIAN	MIN	MAX
High School RCT									
10NWEA-Fall	LV-ALL	227.28	11.8	1.9	223.43	231.13	229	196	246
	C-ALL	226.09	9.91	1.49	223.07	229.1	226	190	241
10NWEA-Spring	LV-ALL	233.23	11.1	1.78	229.63	236.83	236	204	253
	C-ALL	225.81	9.9	1.49	222.81	228.83	228	193	240
10NWEA-GROWTH	LV-ALL	6.282	7.189	1.15	3.952	8.162	5	-6	25
	C-ALL	-0.295	6.476	0.976	-2.264	1.673	0.5	-16	14
10NWEA-F	LVANGL	229.57	11.22	2.12	225.21	233.92	231.5	196	246
	LVLATIN	221.17	11.49	3.316	213.87	228.46	218.5	203	239
	CANGL	229.22	7.419	1.429	226.29	232.15	229	213	241
	CLATIN	221.12	11.47	2.781	215.2	227.01	223	190	239
10NWEA-S	LVANGL	235.93	9.79	1.851	232.13	239.73	238	211	253
	LVLATIN	225.67	11.42	3.297	218.4	232.9	225	204	243
	CANGL	229.11	8.1	1.558	225.91	232.31	230	197	240
	CLATIN	220.58	10.45	2.535	215.21	225.96	224	193	234
10NWEA-F	LVBOYS	226.95	11.1	2.43	221.89	232.01	229	203	242
	LVGIRLS	227.16	12.87	2.95	220.96	233.36	228	196	246
	C-BOYS	225.37	8.46	1.73	221.8	228.95	225.5	204	240
	C-GIRLS	226.95	11.57	2.59	221.53	232.37	228.5	190	241
10NWEA-S	LVBOYS	233.33	11.25	2.55	228.21	238.46	236	204	252
	LVGIRLS	232.31	11.47	2.63	226.79	237.84	236	211	253
	C-BOYS	225.54	8.69	1.77	221.87	229.21	226	197	237
	C-GIRLS	226.15	11.4	2.55	220.81	231.47	228.5	193	240

Grade 10 Reading Comprehension Test Scores. NWEA=Northwest Education Association MAP Reading Score. F=Fall 2003. S=Spring 2004. LV=Live Ink, C=Control, ANGL=English Native Lang, LATIN=Non-Native English Lang.

GRADE-TEST-TIME	GROUP/SUB	Mean	SD	SEM	95%CI -- LOWER	95%CI - UPPER	MEDIAN	MIN	MAX
High School RCT:									
11pretest (CSAP-10spring)	LV-ALL	690.94	44.25	7.95	674.7	707.17	692	545	742
	C-ALL	679.62	35.33	6.56	666.17	693.06	682	600	733
	LV-ANGLO	699.26	37.59	7.84	683	715	708	612	743
	LV-LATINO	667	55.4	19.59	620	713	683	545	725
	CON-ANGLO	678.39	35.56	7.41	663.01	693.77	673	600	733
	CON-LATINO	684.33	37.35	15.25	645.13	723.53	694	613	722
	LV-BOY	687.06	38.2	9.55	666.7	707.42	689	612	742
	LV-GIRL	691.64	51.6	13.65	662.15	721.12	705	545	742
	CON-BOY	678.78	43.41	10.23	657.19	700.38	682.5	600	743
	CON-GIRL	686.167	24.15	6.97	670.82	701.6	687	647	729
11ACT-POST-INTV	LV-ALL	21.06	4.46	0.801	19.42	22.69	20	13	32
	CON-ALL	18.35	5.01	0.932	16.44	20.25	17	12	29
	LV-ANGLO	21.04	4.18	0.872	19.23	22.85	20	17	32
	LV-LATINO	21.125	5.49	1.941	16.54	25.71	21.5	13	29
	CON-ANGLO	18.7	5.13	1.07	16.48	20.91	17	12	29
	CON-LATINO	17	4.73	1.932	12.03	21.97	16	12	26
	LV-BOY	20.125	4.15	1.036	17.92	22.33	19.5	13	29
	LV-GIRL	21.86	4.8	1.283	19.08	24.63	20	16	32
	CON-BOY	18.55	5.25	1.237	15.95	21.17	17	12	29
	CON-GIRL	18.53	5.036	1.457	15.38	21.78	16.5	13	26

Grade 11 Reading Comprehension Test Scores. Colorado Student Academic Progress (CSAP) Reading taken in spring of the 11th graders' 10th grade (prior year, pretest). ACT posttest.

GRADE-TEST-TIME	GROUP/SUB	Mean	SD	SEM	95%CI -- LOWER	95%CI - UPPER	MEDIAN	MIN	MAX
Prospective Matched Case-control									
8NWEA-F	LV-LL	221.97	15.23	1.93	218.1	225.83	224.5	171	247
	C-ALL	222.82	14.97	1.9	219.02	226.62	225	173	249
8NWEA-S	LV-ALL	229.35	12.82	1.63	226.1	232.61	231	189	256
	C-ALL	222.43	18.05	2.29	217.85	227.02	226.5	132	253
8NWEA-GROWTH	LV-ALL	7.322	5.901	0.75	5.822	8.822	7	-8	23
	C-ALL	1.251	5.77	0.733	-0.208	2.724	2	-11	17
8NWEA-F	LVANGL	225.9	10.53	1.49	222.9	228.9	225	193	247
	LVLATIN	206.61	20.14	5.59	194.44	218.79	204	171	238
	CANGL	227.34	10.63	1.55	224.21	230.46	227	192	249
	CLATIN	207.92	18.29	4.91	197.31	218.54	207	173	236
8NWEA-S	LVANGL	232.5	10.31	1.46	229.57	235.42	232	204	256
	LVLATIN	216.46	13.78	3.82	208.13	224.79	217	189	237
	CANGL	226.23	18.52	2.41	221.28	231.09	228	132	253
	CLATIN	209.93	18.49	4.94	199.25	220.6	212	169	236
8NWEA-F	LVBOYS	220.81	15.5	2.98	214.68	226.95	224	171	244
	LVGIRLS	222.86	15.17	2.56	217.64	228.07	225	171	247
	C-BOYS	221.83	15.18	2.82	216.05	227.6	225	176	244
	C-GIRLS	223.7	14.96	2.6	218.39	229	225	173	249
8NWEA-S	LVBOYS	228.48	12.06	2.32	223.71	233.25	229	189	248
	LVGIRLS	230.02	13.52	2.29	225.38	234.67	232	194	256
	C-BOYS	223.1	13.83	2.57	217.84	228.36	227	185	244
	C-GIRLS	221.85	21.29	3.71	214.3	229.4	225	132	253
Grade 8									

GRADE-TEST-TIME	GROUP/SUB	Mean	SD	SEM	95%CI -- LOWER	95%CI - UPPER	MEDIAN	MIN	MAX
Prospective Matched Case-control									
7NWEA-F	LV-ALL	216.75	14.59	2	212.73	220.78	218	155	237
	C-ALL	216.78	14.1	1.92	212.92	220.63	219	160	238
7NWEA-S	LVALL	224.94	13.34	1.83	221.26	228.62	230	171	243
	C-ALL	219.31	13.98	1.9	215.5	223.13	222	161	243
7NWEA-GROWTH	LVALL	8.245	6.09	0.836	6.567	9.924	8	-4	24
	C-ALL	2.537	5.12	0.697	1.13	3.935	2.5	-9	14
7NWEA-F	LVANGL	220.58	9.59	1.46	217.63	223.53	221	193	237
	LVLATIN	200.3	20.73	6.56	185.47	215.13	204	155	227
	CANGL	221.6	8.95	1.42	218.73	224.46	224	201	238
	CLATIN	203	17.17	4.59	193.08	212.92	208	160	221
7NWEA-S	LVANGL	228.7	8.63	1.32	226.04	231.35	230	212	243
	LVLATIN	208.8	17.98	5.69	195.93	221.67	210	171	231
	CANGL	224	9.04	1.43	221.11	226.89	224.28	195	243
	CLATIN	205.93	17.07	4.56	196.07	215.78	211.5	161	226
7NWEA-F	LVBOYS	216	16.18	3.24	209.76	223.11	221	155	233
	LVGIRLS	217.04	13.31	2.52	211.87	222.2	215	176	237
	C-BOYS	216.5	15.51	3.04	210.23	222.77	220.5	160	235
	C-GIRLS	217.04	12.95	2.45	212.01	222.06	218.5	178	238
7NWEA-S	LVBOYS	225.96	14.3	2.86	220.06	231.86	230	171	243
	LVGIRLS	224.04	12.62	2.39	219.14	228.93	226	193	242
	C-BOYS	219.11	15.76	3.09	212.75	225.48	221	161	240
	C-GIRLS	219.5	12.39	2.34	214.69	224.31	222	185	243
Grade 7									

GRADE-TEST-TIME	GROUP/SUB	Mean	SD	SEM	95%CI -- LOWER	95%CI - UPPER	MEDIAN	MIN	MAX
Grade 6; Prospective, Matched Case-control									
6NWEA-F	LVALL	208.36	18.26	2.41	203.5	213.2	213	143	234
	C-ALL	208.43	17.69	2.34	203.7	213	213	156	235
6NWEA-S	LVALL	219.67	11.88	1.57	216.51	222.82	222	186	240
	C-ALL	209.68	18.365	2.43	204.81	214.56	214	148	232
6NWEA-GROWTH	LVALL	11.33	10.9	1.44	8.44	14.22	9	-2	66
	C-ALL	1.263	8.538	1.13	-1.002	3.528	2	-33	28
6NWEA-F	LVANGL	215.5	13.81	2.37	210.67	220.32	219	175	234
	LVLATIN	197.82	19.16	4	189.53	206.11	200	143	229
	CANGL	213.51	15	2.47	208.51	218.51	218	175	235
	CLATIN	199.05	18.79	4.2	190.25	207.85	202.5	156	229
6NWEA-S	LVANGL	224.44	10.13	1.74	220.9	227.98	226	193	240
	LVLATIN	212.61	10.86	2.26	207.92	217.3	212	186	230
	CANGL	214.7	16.03	2.64	209.35	220.04	217	148	232
	CLATIN	200.4	19.16	4.28	191.43	209.37	206.5	154	223
6NWEA-F	LVBOYS	205.88	19.01	3.26	199.24	212.51	211	143	234
	LVGIRLS	212.04	16.8	3.51	204.77	219.3	217	175	234
	C-BOYS	208.56	16.5	2.92	202	214	212.5	161	235
	C-GIRLS	208.28	19.44	3.89	200.25	216.3	213	156	233
6NWEA-S	LVBOYS	219.08	11.12	1.91	215.2	222.9	221	186	238
	LVGIRLS	220.5	13.1	2.74	214.8	226.1	222	193	240
	C-BOYS	210.03	17.05	3.01	203.88	216.17	216.5	154	232
	C-GIRLS	209.24	148	4.06	200.9	217.6	213	221	

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